UNIVERSITY OF MICHIGAN
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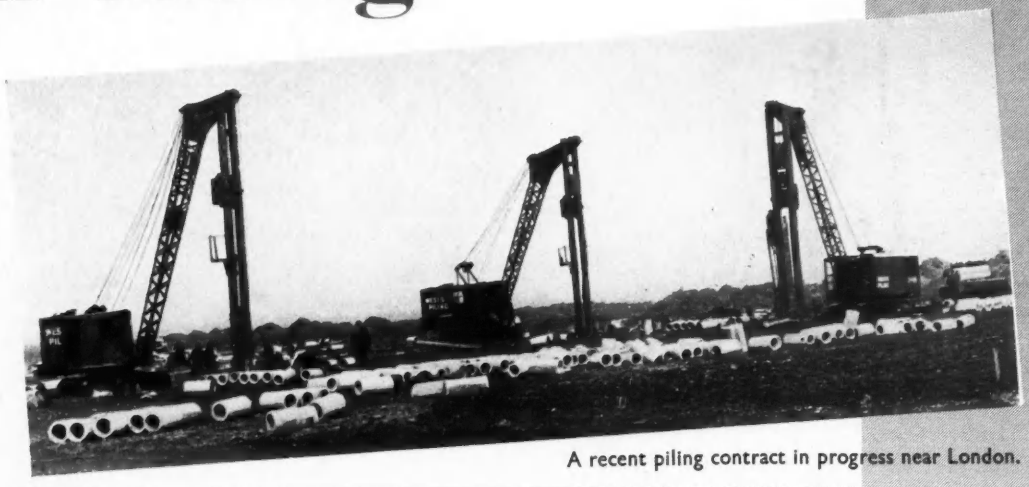
ENGINEERING LIBRARY

The Engineer

DECEMBER 25, 1953 28, ESSEX ST., STRAND, LONDON, W.C.2 TWO SHILLINGS

Piling



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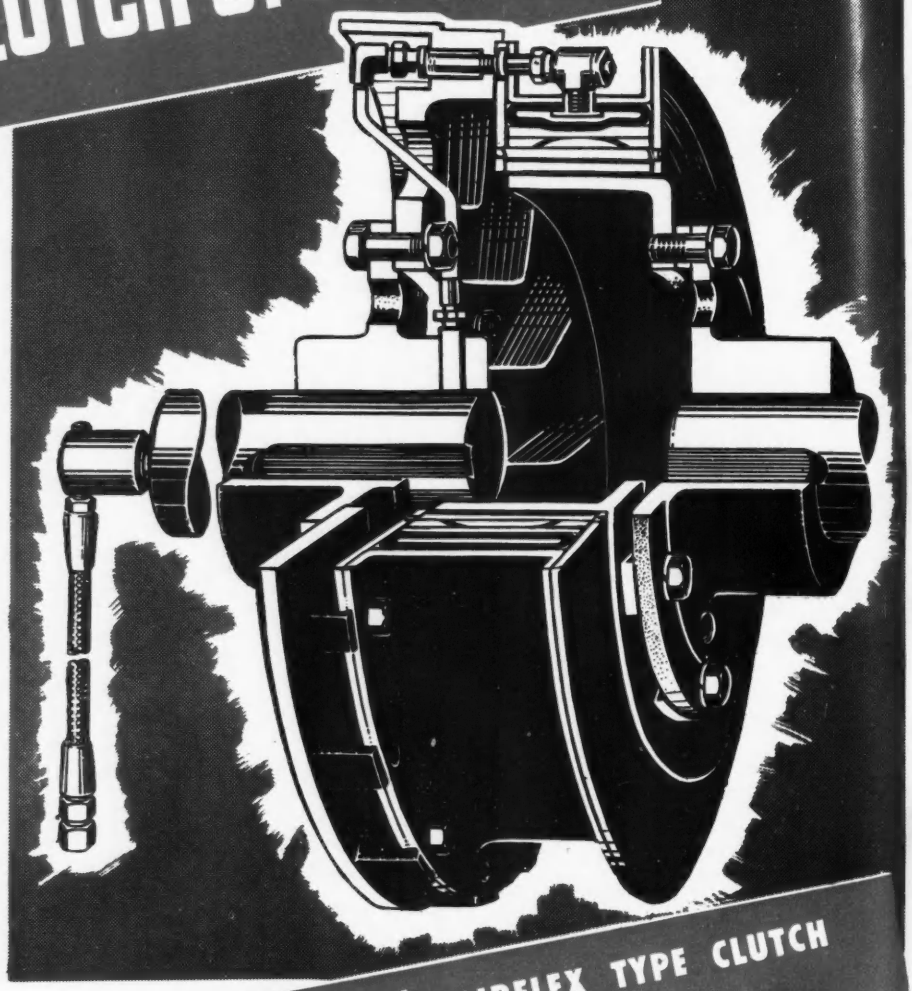

THE ADVANCED CROFTS AIRFLEX TYPE CLUTCH
with the exclusive ventilated adapter

PUBLICATION A/851/10

DRUM-TYPE AIR OPERATION

Only CROFT'S AIRFLEX CLUTCHES provide (1) 360° friction surface. (2) uniform friction pressure, (3) constant-velocity contact between the full width of the friction shoes and the drum.

INSTANTANEOUS ACTION

The sensitive, split-second air operation of the actuating tube reduces shaft vibrations, compensates for accidental misalignment, and absorbs operating shocks and variable axial pressures.

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The CROFT AIRFLEX CLUTCH design lends itself to maximum heat dissipation through the ventilated adapter, which creates forced air circulation through the mechanism—providing cooler clutch operation and eliminating excess wear.

SELF-ADJUSTING

The rugged AIRFLEX actuating tube automatically compensates for wear of friction shoes. This ensures complete engagement and dependable service without mechanical adjustment.

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CROFT'S AIRFLEX design and construction eliminate the problem of clutch lubrication. Uniform friction-shoe wear reduces lost production time for maintenance.

CROFT'S AIRFLEX CLUTCHES on your machines will provide new standards of high production and low maintenance. Thousands of "performance-proved" industrial installations have demonstrated why you should investigate the exclusive CROFT design and operating superiority—as applied to your specific equipment. The CROFT CLUTCH ENGINEERING service is available for co-operative effort to improve your equipment. Write or wire Main Office, Bradford, England.

Crofts INDUSTRIAL CLUTCH DIVISION

MANUFACTURERS OF EVERY TYPE OF INDUSTRIAL CLUTCH

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Power Transmission Engineers.
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Telephone : 65251 (15 lines)
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Wickman Optical

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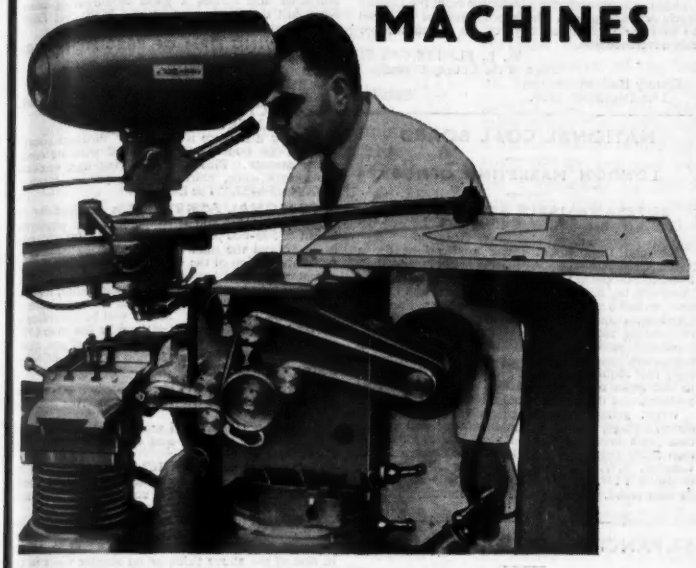
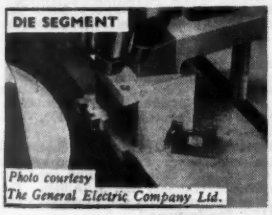
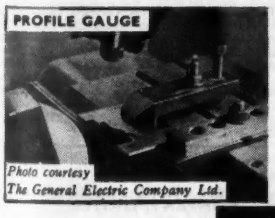
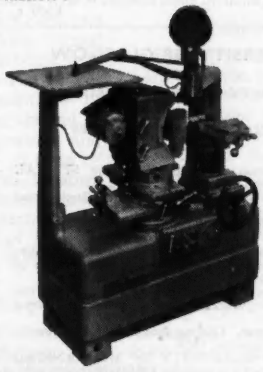


increase output in the up-to-date toolroom





These machines are currently used in the toolrooms of a host of important aircraft, automobile, watchmaking and general engineering organisations for the production of profile gauges, form tools, press tools and many other highly precise aids to production. We would like you to meet some of the users —"The most helpful piece of equipment we've got," says one: and another, "We could not produce our type of work without it." Why not let us take you round, or send you fuller information ?



Wickman

WICKMAN of COVENTRY

327 WMG

THE ENGINEER

ESTABLISHED 1856

Vol. 196 No. 5109

DECEMBER 25, 1953

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NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

SUBSCRIPTIONS

U.K. & ABROAD £5. 10. 0. CANADA £5. 5. 0. annually including postage. Every subscriber is entitled to one FREE copy of the BUYERS GUIDE as published —extra copies 5s. each post free.

CLASSIFIED ADVERTISEMENTS

LINEAGE RATE (Under 1 inch):—2s. 6d. per line of 6 words. Minimum 10s.

INCH RATE (1 inch and over):—Rates per insertion per single column inch— 1 insertion—30s 6 insertions—27s. 6d. 13 insertions—26s. 26 insertions—25s.

USE OF BOX NUMBER: The charge is 2s. including the cost of re-addressing replies, which are forwarded immediately on receipt. N.B. There is no Charge for Box Nos. under "Situations Wanted."

WORDING OF ADVERTISEMENTS: Approximately the first 25 letters of each advertisement are set in heavy type. Advertisers are therefore advised to begin their advertisements with the words they want emphasized.

Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

LEICESTERSHIRE EDUCATION COMMITTEE

COALVILLE MINING AND TECHNICAL COLLEGE

Principal: W. A. BURROWS, B.Sc.

HEAD OF DEPARTMENT OF MINING AND ENGINEERING, GRADE II

Applications are invited for this important appointment. A man of drive and organising ability with high qualifications and wide experience in mining and teaching is required. Mine surveying qualifications an advantage.

The College serves the Leicestershire and South Derbyshire Coalfield.

Salary £1040 by £25 to £1190 per annum (plus £25 per annum if new scales are adopted). Consideration given to registered disabled persons.

Apply by letter (no forms) to the Principal, giving full details of age, education, qualifications and experience, three referees and copies of two recent testimonials, by Tuesday, January 19th, 1954. E6486

GLANTAWE HOSPITAL MANAGEMENT COMMITTEE

SWANSEA HOSPITAL

ENGINEER IN CHARGE

Applications are invited for the appointment of ENGINEER IN CHARGE at the above hospital. Applicants must have served a full apprenticeship in mechanical engineering and have a sound knowledge of the principle and practice of the efficient operation of institutional boiler plants and engineering services generally, and must also possess electrical experience. He will be required to take charge of the engineering and building maintenance staffs stationed at the above hospital, and will be responsible for the maintenance of the engineering plant and services, as well as the fabric of the buildings at the above hospital and at other hospitals in the Swansea Sub-Group. He will be responsible to the Group Engineer and work under his direction.

Possession of one or more of the following qualifications is essential :—

Higher or Ordinary National Certificate or Diploma in Mechanical Engineering.

First-Class Certificate of Competency in Marine Engineering or the equivalent Naval Certificate.

Salary scale £525 by £20 to £625.

The appointment is subject to the provisions of the National Health Service Superannuation Regulations, and the passing of a medical examination, and is terminable by one month's notice either way.

Applications, stating age, training, qualifications and experience, together with the names of three referees (two technical), should be forwarded to the undersigned to be received not later than Saturday, 2nd January, 1954.

O. C. HOWELLS, Group Secretary,
Glantawe Hospital Management Committee.
St. Helen's Road, Swansea. E6446

HER MAJESTY'S COLONIAL SERVICE

WAY AND WORKS, MALAYAN RAILWAYS

ENGINEER

Applications are invited for the following post: ENGINEER, Way and Works, Malayan Railways.

Duties include taking charge of a railway district of about 150 miles, with responsibility for maintenance of permanent way, bridges, buildings, and for supervision of works within the district.

Appointment is permanent and pensionable, subject to satisfactory completion of three-year probationary period, with gross emoluments (depending on age, experience, war service and marital status) in the incremental range £1218 to £2730 p.a.

Candidates, who should be between 25 and 35 years of age, must hold a recognised University Degree or Diploma in Civil Engineering, carrying exemption from, or have passed Parts I and II of the A.M.I.C.E. examination, or be A.M.I.C.E. They must have had experience of civil engineering works on a railway; experience of modern methods of permanent way maintenance with flat-bottomed rails would be an advantage.

Full details on application.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number CDE 110/60/02. E6528

MINISTRY OF SUPPLY

RESEARCH BRANCH

ENGINEER, PHYSICIST OR MATHEMATICIAN

Ministry of Supply requires ENGINEER, PHYSICIST or MATHEMATICIAN at Research Branch, Tolworth, Surbiton, to work on design and development of wide range of survey, photographic and printing equipment. Qualifications: 1st or 2nd-class Honours Degree or equivalent in an appropriate subject, with at least 3 years' relevant post-graduate experience. Administrative experience desirable. Salary within range: Senior Scientific Officer (min. age 26), £917–£1075. Women somewhat less. Appointment unestablished. F.S.S.U. benefits may be available.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A194/53A. E6504

PUBLIC APPOINTMENTS

HER MAJESTY'S COLONIAL SERVICE

PUBLIC WORKS DEPARTMENT, CYPRUS

ENGINEER

Applications are invited for the following post: ENGINEER, Public Works Department, Cyprus.

Duties: Supervision of general engineering works, particularly buildings. Preparation of projects, estimates, bills of quantities, &c., under direction of Director of Public Works or Divisional Engineer. Selected candidate will work on construction of Nicosia General Hospital in first instance.

Appointment on contract for 2 years. Salary: £1110 p.a. (fixed). Overseas allowance at rate of 10 per cent of basic salary and temporary variable cost-of-living allowance of 12½ per cent of basic salary is payable. Gratuity on satisfactory completion of contract.

Government quarters at low rental or allowance payable in lieu. Free first-class passages.

Candidates must hold a recognised University Degree or diploma carrying exemption from, or have passed, Final Parts I and II of the A.M.I.C.E. examinations or be A.M.I.C.E. They should have had at least two years' practical experience of civil engineering and have knowledge and experience of control of building projects.

Full details available on application.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number CDE112/17/02. E6506

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

FUEL SECTION OF THE PHYSICS DEPARTMENT

TECHNICAL ASSISTANT

TECHNICAL ASSISTANT is required by the Fuel Section of the Physics Department of the above Association. The work will be of a varied and interesting nature, and initially will be largely in connection with the utilisation, instrumentation and design of furnaces, and with operational studies involving the heating and cooling of steel ingots. Location of work London, but periodical visits will be made to iron and steel works in various parts of the country to carry out special investigations.

Applicants should possess a National or Higher National Certificate in Science or Engineering, Inter. B.Sc., or equivalent qualification. Time off for study for further qualifications will be given. Salary according to age, qualifications and experience.

Written applications, giving full details of age, qualifications and experience, and quoting "Fuel," should be sent to the Personnel Officer, B.I.S.R.A.,11, Park Lane, London, W.1. E6482

THE PARSONS AND MARINE ENGINEERING TURBINE RESEARCH AND DEVELOPMENT ASSOCIATION (PAMETRADA)

The Parsons and Marine Engineering Turbine Research and Development Association (Pametrada) invites applications for the following vacancies :—

(1) INSTRUMENT ENGINEERS, to supervise the maintenance, calibration and installation of instruments on research assemblies, and to advise on means of measurement and the choice of instruments.

(2) MECHANICAL ENGINEER, for research and development work on steam and gas turbine components.

(3) ENGINEERS or SCIENTISTS, for research on combustion, aerodynamics and heat transfer.

(4) ENGINEERS, for design work on steam and gas turbine machinery.

(5) MECHANICAL ENGINEERS, to assist in the full-scale testing of steam and gas turbine machinery.

Candidates should not be more than about 35 years of age and should preferably possess good Honours Degrees, but consideration will also be given to experienced men with equivalent qualifications.

Salaries compare favourably with those in the Scientific Civil Service, and there are excellent superannuation and other benefits.

Apply in writing to Research Director, Pametrada Research Station, Walisend, Northumberland. E6425

LEYTONSTONE (No. 10) HOSPITAL GROUP

LANGTHORNE HOSPITAL, E.11

ASSISTANT ENGINEER

ASSISTANT ENGINEER required at Langthorne Hospital, E.11. The successful candidate will be immediately responsible to the Engineer-in-Charge in assisting with the operation of the engineering services, including both mechanical and electrical. Candidates must have completed an apprenticeship in mechanical engineering or by other means acquired a sound practical training in mechanical engineering, and in addition have undertaken a course of study in the technology of engineering. Applicants must also be in possession of an Ordinary National Certificate of Mechanical Engineering, which includes heat and heat engines as a subject, and preferably has an endorsement in the principles of electricity, or alternatively an approved equivalent qualification. It will be an advantage if applicants also possess a good knowledge of building and repair work. Salary scale £475 by £15 to £550 per annum, plus appropriate London weighting.—Application forms from the Group Secretary, Langthorne Hospital, E.11, to be returned by the 7th January, 1954. E6521

PUBLIC APPOINTMENTS

KENT COUNTY COUNCIL

BUILDINGS DEPARTMENT

ENGINEERING ASSISTANT (HEATING AND MECHANICAL)

Applications are invited for appointment in the Buildings Department of an ENGINEERING ASSISTANT (Heating and Mechanical) at a salary in A.P.T. Grades IV–V (£555–£645).

Applicants must have passed Sections A and B of the examination for Associate Membership of the Institution of Heating and Ventilating Engineers and have had good experience in the preparation of schemes, specifications and estimates for all classes of heating, hot and cold water supplies and ventilation work. The duties will include the preparation of drawings, inspection of premises and supervision of installation works.

Applications, on forms obtainable from the County Architect, Springfield, Maidstone, must be delivered to him within fourteen days of the appearance of this advertisement.

W. L. PLATTS,
Clerk of the County Council.
County Hall, Maidstone,
11th December, 1953. E6487

NATIONAL COAL BOARD

LONDON MARKETING OFFICE

SUPERANNUABLE APPOINTMENT

National Coal Board invite applications for a SUPERANNUABLE APPOINTMENT in their London Marketing Office, W.C.1. Salary on appointment will be, according to qualifications and experience, within a scale £945 by £35 to £1320 per annum. Candidates should be experienced in combustion engineering technique and should have some commercial experience. Duties will include visits to consumers' premises for the purpose of advising on their fuel requirements and problems, having regard to the types of plant installed, the grades of coal available and the need for fuel economy.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting this paper and marking envelope TT/722. Original testimonials should not be forwarded. Closing date 14th January, 1954. E6514

ST. PANCRAS BOROUGH COUNCIL

APPOINTMENT OF ENGINEERING ASSISTANT

Applications invited for above appointment in Borough Engineer and Surveyor's Dept. Salary £710–£785 p.a. (A.P.T. VII), plus London weighting. Candidates should be Associates of Institution of Civil Engineers or Municipal Engineers, or hold other suitable qualifications. Application forms and further particulars from undersigned. Closing date 2nd January.

R. C. E. AUSTIN,
Town Clerk.
St. Pancras Town Hall,
Euston Road, N.W.1. E6496

EDUCATIONAL

A.M.I.MECH.E., B.SC., CITY AND GUILDS, &c. Guaranteed postal courses for all Exams. and Technical Divisions from Elementary to Degree Standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 17, Stratford Place, London, W.1. E505

UNIVERSITY OF GLASGOW

FACULTY OF ENGINEERING

SPECIAL SHORT COURSES

The University offers the following SPECIAL COURSES for Designers and others (Graduate or Non-Graduate) employed in Mechanical Engineering and Chemical Engineering.

COURSE IN HEAT TRANSFER,
February 1st to 12th, 1954.

Calculations in conduction, convection and radiation; induction and dielectric heating; design of heat exchangers; design of boiler furnaces.

The forenoons will be devoted to lectures and the afternoons to experiments, demonstrations and works visits.

Fee, 15 guineas. Closing date for receipt of applications 22nd January, 1954.

COURSE IN PLASTICITY IN MECHANICAL ENGINEERING DESIGN,
May 3rd to 14th, 1954.

Fundamental experimental work on tubes; general elementary mathematical theory; applications to shrink fits, pressure vessels, compression members and general mechanical design. Related topics: creep in metals, internal damping, photoelasticity.

The forenoons will be devoted to lectures and the afternoons to experiments, demonstrations, &c.

Fee, 15 guineas. Closing date for receipt of applications 15th April, 1954.

Applications for admission to either of the above courses should be addressed to the undersigned, from whom further particulars may be obtained.

ROBERT T. HUTCHESON,
Registrar.
The University,
Glasgow, W.2. E6510

SITUATIONS VACANT

NOTIFICATION OF VACANCIES ORDER, 1952

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18–64 inclusive or a woman aged 18–59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A GRADUATE MECHANICAL ENGINEER aged 25–35 years, having a First or Second-Class Honours Degree, is required by a national organisation for a permanent appointment on work concerned with research and development of production processes. The work is varied and interesting and may include liaison with engineering firms throughout the country. Excellent prospects for man with initiative and personality. The position is superannuated and carries a good commencing salary. Send full details in confidence.—BOX No. E6508, "The Engineer."

A GROWING FIRM OF PRECISION ENGINEERS requires :
GENERAL MACHINE SHOP SETTER,
TOOLMAKER,
CENTRE LATHE TURNER for prototype work,
PRODUCTION TURNER,
CAPSTAN SETTER OPERATOR.
Housing assistance if required. Pleasant country district, one hour London. Good working conditions, canteen. Please write, giving age, qualifications, experience, married/single, present wages.—BOX No. E6452, "The Engineer."

A PERSONAL ASSISTANT is required for the General Manager and Director of a firm employing a staff of 500–600 people. The age bracket envisaged is 28–32 and the man selected must be capable of rapid absorption of the works organisation and early acceptance of direct control of four factory managers. An engineering or accountancy qualification, together with practical industrial experience for a minimum of three years, is essential. Salary will be according to age and qualifications, but will not be less than £1000 per annum to commence. Full details of age, qualifications and career to date should be sent.—BOX No. E3030, "The Engineer."

AN AIRCRAFT FIRM in the North-West have the following vacancies in their engineering research department :—

(a) Two TECHNICIANS are required to operate a high-altitude chamber and carry out tests on aircraft components.

(b) A number of TECHNICIANS are required for work in connection with the testing of hydraulic systems, power-operated controls and airframe structures.

Candidates for these vacancies should be of Higher National Certificate or Degree standard, and preference will be given to those who have had experience in one of the above fields or on similar work in the aircraft industry. The work is of an interesting nature on advanced designs, salaries offered being attractive and commensurate with age and experience. Applications, stating full details, including salary required, should be addressed.—BOX No. E3004, "The Engineer."

AN EXCEPTIONAL OPPORTUNITY exists for a man between 30 and 35 to enter a large and well-known industrial firm in the North-West as Personal Assistant to the Works Director. The company manufactures a wide range of products and is steadily expanding. A good Engineering Degree or its equivalent is desirable, together with a varied executive experience in industry. Practice as a management consultant would also be an advantage. Reply, stating age, experience and salary expected.—BOX No. E2985, "The Engineer."

AN EXPERIENCED FOUNDRY MANAGER required for light, medium and heavy ferrous and non-ferrous foundry in the Leeds district, capacity up to 400 tons finished castings per month. Experience of mechanisation essential. Pension scheme in force. Assistance to procure a house, if necessary. Apply, stating age, experience and salary required.—BOX No. E3014, "The Engineer."

ASSISTANT CIVIL ENGINEER wanted for site supervision on a colliery project in South Wales. Applicants should preferably be Corporate Members of the Institution of Civil Engineers and should possess good experience in high-grade concrete construction. Experience in tunnel work and construction of deep well linings will be an asset.—Apply by letter marked "Concrete," with full particulars of age, qualifications, experience and salary required, to Rendel, Palmer and Tritton, 125, Victoria Street, London, S.W.1. E6519

ASSISTANT DRAUGHTSMAN required for mechanical engineering. Preferably, but not necessarily, a man with civil engineering contractor's plant experience. Locality near St. Albans. Please write, giving full particulars and experience.—BOX No. E2957, "The Engineer."

ASSISTANT WORKS MANAGER required by engineering company in the Midlands. Age 35/45, with a thorough experience of batch production and a wide knowledge of machining operations. Applicant must be fully conversant with piecework and have proved ability in management/employee relations. The position is progressive and offers exceptional opportunities of advancement. State age, education and experience in full.—BOX No. E2994, "The Engineer."

BRITISH TITAN PRODUCTS COMPANY, LIMITED,
has a vacancy at its
Grimsby factory for
AN EXPERIENCED ENGINEER
for large Steam-Raising Plant.

Salary dependent on age, qualifications and experience. Staff bonus and superannuation schemes.—Application forms may be obtained from the Secretary of the Company, Kronos House, Coppergate, York. E6525

BLAW KNOX, LTD., Rochester, require experienced Jig and Tool Draughtsman and experienced Plate Shop Rate Fixer.—Apply, Personnel Manager, Esplanade, Rochester, Kent. E6497

THE ENGINEER

DECEMBER 25, 1953

Insignia Award in Technology

ABOUT a year ago, the Insignia Award in Technology was established by the council of the City and Guilds of London Institute to provide a high qualification for persons in industry whose initial training was based primarily upon practical experience combined with theoretical study and who, having gained appropriate City and Guilds' certificates as craftsmen or technicians, have now advanced in their industry by a combination of progressive experience and further study. A candidate upon whom "the City and Guilds of London Institute's Insignia Award in Technology" is conferred will receive a warrant specifying the section of industry and the branch of technology in which his knowledge and skill are recognised, and under the Institute's Royal Charter he will be authorised to use the insignia letters "C.G.I.A." A register of insignia awards will be maintained by the Institute. The regulations state that a candidate must be at least thirty years of age and be sponsored by three referees of appropriate standing. He must have been apprenticed or otherwise suitably trained in his industry, he must hold relevant full technological certificates of the Institute, and have had a minimum of seven years' progressive experience in his industry. He is then required to write a thesis of some 10,000 to 20,000 words on a technological topic associated with his work, which must show that the candidate is acquainted with the current practice and problems of his industry at technological level. Finally, if this thesis is reported upon satisfactorily by the assessor appointed by the Institute, the candidate is required to appear for interview before an *ad hoc* panel nominated by the Institute. The Insignia Award Committee, on the recommendation of the panel, will then make its final decision as to the award, subject to ratification by the council of the Institute. There is no special timetable involved in the scheme, each candidate being considered as a separate case. The Institute has explained that candidates are considered in five broad industrial groups, namely: chemical industries, constructional industries, electrical industries, mechanical industries, and textile industries. A committee includes two representatives from each of these sections of industry, together with co-opted members. The committee thus offers a collective guarantee to industry that the standards of the award will be kept at a level consonant with the high aims and purpose of the council. Considerable formal and informal contact has been established with a number of professional and industrial bodies and with responsible individual members of industry, who have helped in enlisting the aid of experts in the role of external assessors and members of the interviewing panels. A copy of the regulations governing the award, together with notes for the guidance of candidates, can be obtained on application to the Department of Technology (I.A.), City and Guilds of London Institute, 31, Brechin Place, London, S.W.7.

Credit Facilities for Shipbuilding

IN the House of Commons, on Thursday of last week, the Chancellor of the Exchequer was asked if he would make a statement on the credit facilities available for the building of new ships in the United Kingdom. In reply to the question, Mr. Butler stated that credit facilities mentioned were not confined to banks, and went on to say that inquiries had been made recently into the position with regard to the terms of repayment under which advances had been made in the past for this and other purposes. The investigations, he said, had revealed that the arrangements at present stipulated for the refunding of loans call for some measure of adjustment. Mr. Butler announced that, consequent upon the result of the inquiries, he had decided that the general arrangements, which had been in operation since December, 1951, for the examination of bank advances referred to the Capital Issues Committee, should be revised. As usual, the Committee would give consideration to the purpose of the bank advances brought to its notice, but in future, he said, it would be a general rule that the period and terms of repayment of any borrowing for such purposes would be a matter which would only be the concern of the bank and its customer. In making this statement the Chancellor of the Exchequer said he felt confident that the sound financial principles, upon which the Capital Issues Committee based its stipulations, would be observed by the banks when settling terms for the granting of credit. With particular reference to shipbuilding, Mr. Butler thought that it would be consistent, with the principles already mentioned, for the banks, at their own discretion, to grant credit facilities upon terms conditioned by the special needs of the shipbuilding industry.

The British Productivity Council

AT a meeting of the British Productivity Council in London last week, Mr. Tom Williamson was elected chairman of the council in succession to Lord Bennett of Edgbaston, who had completed a year in office. At the same meeting, Sir Ewart Smith was elected deputy chairman in succession to Sir Lincoln Evans. Lord Bennett will remain a member of the council, but Sir Lincoln Evans, who earlier this year was appointed vice-chairman of the Iron and Steel Board, has resigned on relinquishing the appointment of general secretary of the Iron and Steel Trades Confederation. Sir Andrew Naesmith, who was also appointed to the Iron and Steel Board, has also resigned from the council. To fill the vacancies on the council the T.U.C. nominated Mr. W. L. Heywood, general secretary of the National Union of Dyers, Bleachers and Textile Workers, and Mr. L. T. Wright, general secretary of the Amalgamated Weavers' Union. Since the council announced last March that it proposed to promote the formation of Local Productivity Committees, seventy-eight committees have been formed, and it is also arranging a series of "Work Study Weeks" in industrial centres.

Railway Accidents in 1952

THE report to the Minister of Transport and Civil Aviation upon the accidents which occurred on the railways of Great Britain during the year 1952 has just been published. In this report, made by Lieut-Colonel G. R. S. Wilson, it is shown that the total number of passengers, railway servants and other persons killed during the year under review was 415, and the total number of injured was 26,114. The accidents are grouped under three headings—train accidents, movement accidents and non-movement accidents. Under the heading of train accidents it is stated that the number reported totalled 1243, and although the total showed a substantial reduction on the previous year there was a heavy increase in the number of casualties. Of the 133 persons killed in train accidents 108 passengers and four railway servants lost their lives in the Harrow collision. Only three passengers were among the twenty-one fatalities in nineteen other train accidents during the year. In movement accidents, which accounted for the deaths of forty-one passengers and injuries to a further 4355, the principal causes were misadventure and carelessness and misconduct on the part of the passengers themselves. Movement accidents also caused the deaths of 171 railway servants and injuries to 2359. Non-movement accidents caused the deaths of three passengers, twenty railway servants and six other persons. The primary cause of the 1243 train accidents during 1952 is attributed to human failure on the part of the operating staff.

Pollution of the Thames

THE Minister of Housing and Local Government, Mr. Harold Macmillan, was questioned in Parliament last week about the research work which had to be undertaken into the problem of the nuisance caused to large numbers of people by effluvia from the River Thames. In his reply, the Minister said that the extensive research, which was still in progress, covered such matters as the quantities, temperature and chemical and biological condition, at various points and times, of the estuary water itself and of the discharges into it. The study included also the nature and behaviour of bottom mud and suspended solids, the volume and movement of liquid within the estuary, and the interactions of these and other factors as affecting the production, oxidation, solution and release of hydrogen sulphide. Mr. Macmillan explained that much of the work was fundamental research, which was now being undertaken for the first time, and the results, he thought, should be of considerable use in relation not only to the Thames, but also to other estuaries. It was already accepted, however, the Minister added, that a major cause of the complaints about the lower reaches of the Thames was the need to improve the purification of London's sewage.

Construction of New Roads

IN the House of Commons, on Friday last, December 18th, there was an adjournment debate, during which the construction and improvement of the country's roads was discussed. It may be recalled that Mr. Lennox Boyd, Minister of Transport and Civil Aviation, made a statement about the Government's plans for expenditure on the roads during the next few years, in the House on December 15th. These proposals have been criticised as inadequate in various quarters, and it was with this point that much of the debate was concerned. Mr. Ellis Smith, who opened the debate, said that he challenged fundamentally the Government's policy on the roads. He pleaded particularly for the industrial areas, and said that fundamental action was required if road accidents were to be reduced, if people were to be transported from their homes to their work as quickly as possible, and if freight were to be carried on the roads as efficiently and cheaply as possible. Mr. Ellis Smith asked for a large loan to finance the construction of the national motor roads. He suggested that the Minister of Transport should use his energy for the purpose of applying to the construction of roads in peacetime that dynamism which was shown in wartime in constructing aerodromes and airfields. The urgency of various specific proposals for improved road communications in different parts of the country was discussed by speakers during the debate. In his reply, Mr. Lennox Boyd pointed out that it was necessary to look at the picture as a whole, and that the utmost economy was still needed in the national finances. Since the Budget of 1947, he said, there had been virtually no money whatever allowed for new construction; at least that freezing in the field of new construction had been broken. He did not think that local authorities themselves had adequate skilled manpower to deal with a much more ambitious programme than the one contemplated. The Government had committed itself to spend £19,000,000 on new construction in the year ahead, he said, and £50,000,000 in the next three years.

Mahanadi Valley Development

(By our Indian Correspondent)

No. II—HIRAKUD DAM PROJECT

(Concluded from page 805, December 18th)

The integrated development of the Mahanadi Valley comprises the construction of three dams at Hirakud, Tikarpara and Naraj, each with its own canal systems and hydro-electric installations. At present the first of these is in execution and, when completed, will be operated as an independent unit. It is here described. All the three can, in fact, be considered separately, although for a fuller realisation of the valley's water resources, they will have to be operated as forming an integral part of the hydro power system.

THE Hirakud site was selected as that upon which to start work, as it is uppermost on the river and also because the construction requirements are somewhat simpler than the other two. The project, begun in 1948, will not be fully completed until 1971, but the first stage involving an expenditure of Rs. 67·43 crores (£50·57 million) out of the total of Rs. 92·08 crores (£69,000,000) for the entire project, is scheduled for completion by 1956.

The works under this project comprise :—

(1) A main storage dam (gross storage 6·75 million acre-feet) across the river at Hirakud, approximately 9 miles upstream of Sambalpur town (Fig. 6) ;

(2) A power house at the main dam and a second power house at the toe of the subsidiary dam ; the subsidiary dam forms a forebay at the end of a power channel carrying the tail waters of the power house at the main dam ; and

(3) Irrigation canals.

The Dam and the Reservoir

At the site where the dam is now being constructed the river is about 1·5 miles wide. The river bed is shallow and has vertical clay banks about 10ft to 13ft high. Water flows through several thin streamlets separated by wide rock outcrops. There is also a wide alluvial stretch occurring as an island within the river bed. Although the site is not an ideal one for the construction of a dam, " it is the only site available within a reasonable distance and cannot be avoided."

The main dam is 15,748ft long ; 3840ft is of concrete and the rest of earth. The concrete structure (Figs. 9 and 10) is a straight massive gravity dam and the earth portion is a zoned rolled fill dam (Figs. 8 and 11). The river bed at the site is divided into two channels by the Hirakud island, and the concrete dam will be in two portions, the one across the left channel being 1640ft long and the other 2200ft long across the right channel. The earth dam will also be in two parts, the left section being 4440ft long and the island section between the two parts of the concrete dam being 7468ft long. In addition to the main earth dam there will be 67,775ft length of earth dykes, also of zoned rolled-fill type, of which just under a half will be on the left flank and the rest on the right flank. A 25ft wide roadway will be provided for the full length of the main earth dam and dykes. The left channel concrete dam will be an all-spillway one and will have forty undersluices, 12ft high by 20ft 4in wide and twenty-one 51ft wide crest bays controlled by 20ft high radial gates. The right channel concrete dam will include the spillway and power sections, and there is provision for future incorporation of a navigation lock. This right spillway section will carry twenty-four undersluices and thirteen crest bays of the same dimensions as in the left spillway portion.

The maximum height of the dam will be 167ft for the concrete dam and 195ft for the earth dam. With the maximum water level at RL. 630, the storage capacity of the reservoir is 6·75 million acre-feet, of which 2·24 million acre-feet is dead storage. The reservoir when full will cover an area of 216,000 acres with a shore line of 155 miles. The question of storage in a valley as flat as at Hirakud raises a number of problems, such as the extent of submergence and the cost of resettlement. It is computed that flood control alone will take up 3·42 million acre-feet and silt reserve will require another

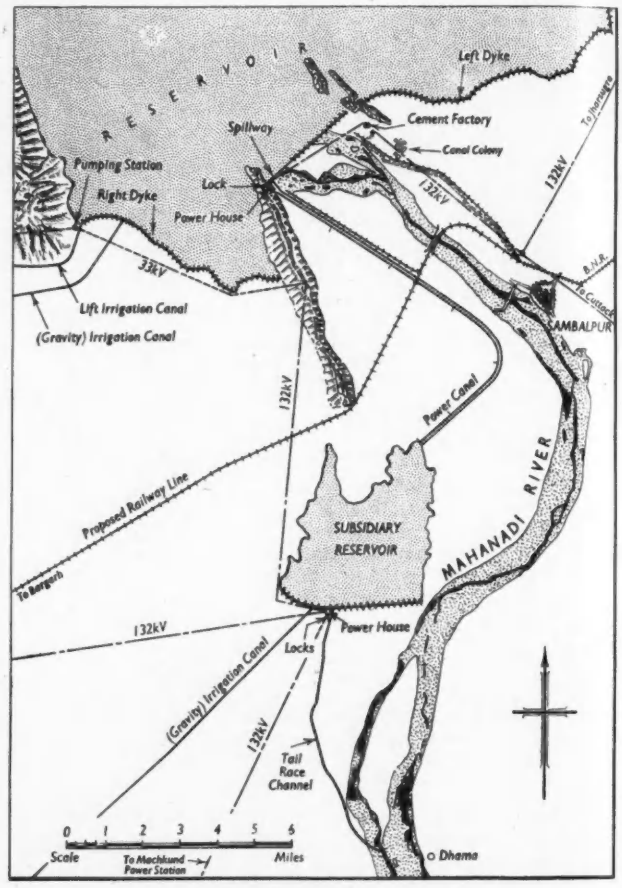


Fig. 6—The Hirakud Project as a Whole

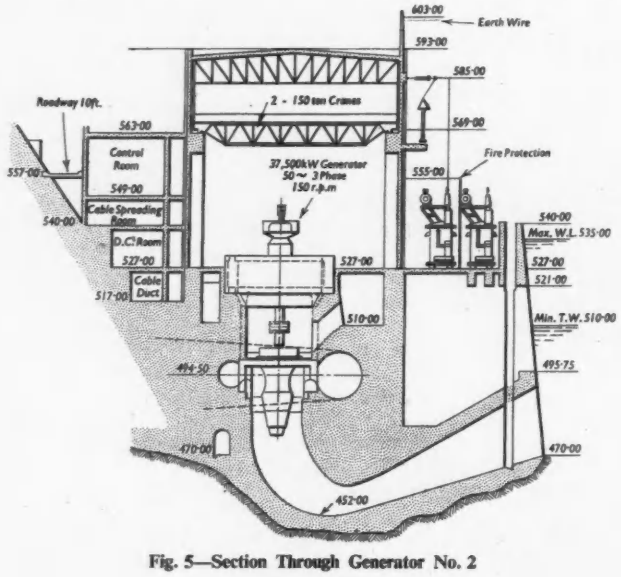


Fig. 5—Section Through Generator No. 2

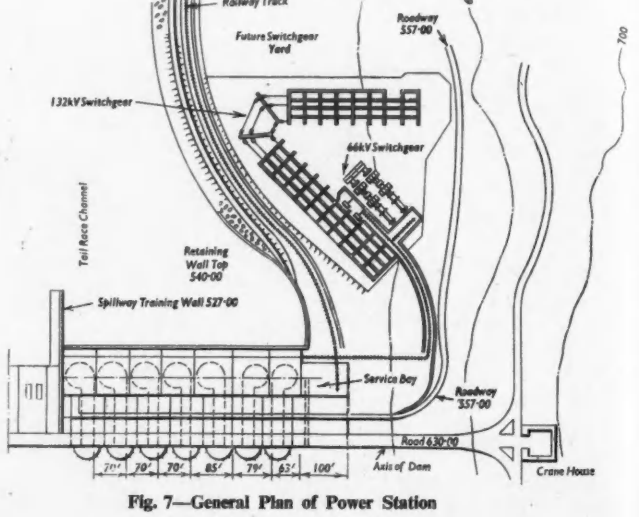


Fig. 7—General Plan of Power Station

1·20 million acre-feet. Fortunately, after the floods are over there is enough water to fill the reservoir for the purposes of power generation. Therefore the entire capacity reserved for flood absorption can be safely filled up after the floods, i.e. in late September. The hydrograph further shows that there is always more than enough water in the river in late September and throughout October to fill the reservoir even in the worst year. Thus the entire live storage capacity of the reservoir including that reserved for flood absorption will be available each year for use in irrigation and power generation.

Silt observations at Hirakud were started in 1946. Silt charge during the period October to February, i.e. after the monsoon, is negligible, but it is considerable during the monsoon months. A quantitative indication is not yet available, but a fairly accurate estimate based on the analogy of similar catchments elsewhere in India reveals that "the annual rate of silt carried by the river from 32,200 square miles of the Mahanadi catchment above Hirakud would not exceed 24,000 acre-feet." Provision will therefore be made for sluices at bed level capable of carrying the bulk of the flood waters. The live storage being only 9 per cent of the mean annual run-off, the total silt trapped in the reservoir would seem to work out at about 2000 acre-feet on a proportionate basis. Actually it will be far more, and it is estimated that on the basis of an annual silt yield of about 10,000 acre-feet it will take about 150 years to fill up the dead storage capacity up to level RL. 590.

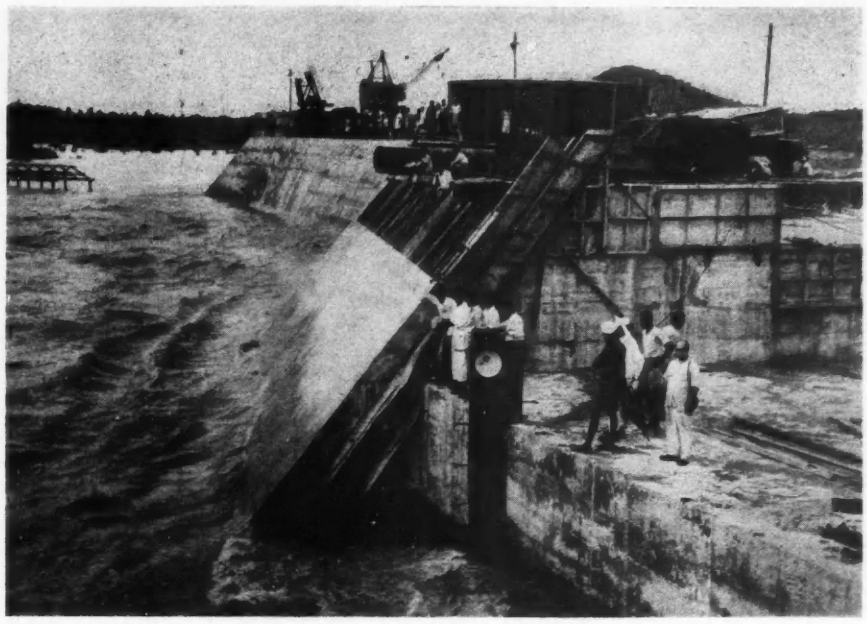


Fig. 8—Left Concrete Dam Under Construction

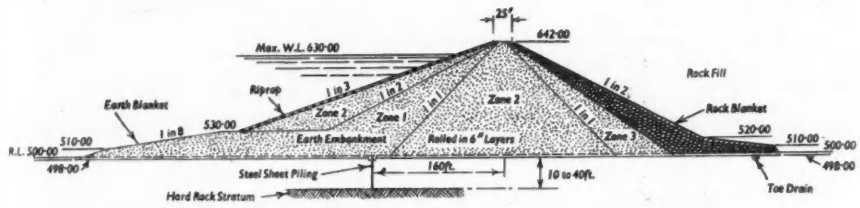


Fig. 9—Cross Section of Earth Dam Founded on River Bottom Material

Irrigation and Power

The project was first conceived as a multi-purpose project with an emphasis on flood control. But owing to the continued shortage of food grains in the country and the resulting bias of the Government's first five-year plan towards agriculture (The Engineer, January 23, 1953), the order of priorities had to be revised in favour of irrigation with the result that many of the schemes envisaged at the start had to be postponed. The order of priorities is now as follows: (1) irrigation, (2) flood control, (3) power, (4) navigation.

There is already in existence an old irrigation system in the delta area which, owing to its inefficiency and age, is reported to be costing the authorities a net loss of about £50,000 per year. The project will provide irrigation facilities in the upper districts of the valley and improve irrigation of existing canals in the delta area and will extend facilities to higher patches by lift irrigation. The area commanded for irrigation is estimated at 1·929 million acres, of which 1·138 million will be in the delta area and the rest in Sambalpur district. There are two main canals taking off from the reservoir, the left being mainly a flow canal serving the Sambalpur district and the right, also a flow canal, serving a lift canal. It is estimated that about 735,000 tons of additional food grains and 297,000 tons of sugar cane will be produced annually, the total being valued at about Rs. 17 crores (£12·75 million). The importance of this production can be gauged from the fact that the food grains alone account for a tenth of the country's present annual deficit of about 7,000,000 tons.

The secondary dam, which was to head up the tail waters of the main power station, has now been postponed along with the 10-mile long power canal leading to it. The power station at the main dam is designed for the ultimate installation of seven generating sets. Initially, two sets each of 37,500kW and two

Programme for Hirakud Dam Project

Stage	Completion	Item	Cost
Stage I, part A ...	Up to 1956	Main dam and dykes; power house for four units and transmission lines; canal system in Sambalpur	Rs. 61 crores
Stage I, part B ...	1956–1961	Additional two units in power house No. 1; additional canal system	Rs. 11 crores
Stage II, part A ...	1961–1966	Subsidiary dam and power house	Rs. 17 crores
Stage II, part B ...	1966–1971	The rest	Rs. 3 crores

(Note.—Rs.1 crore = £750,000).

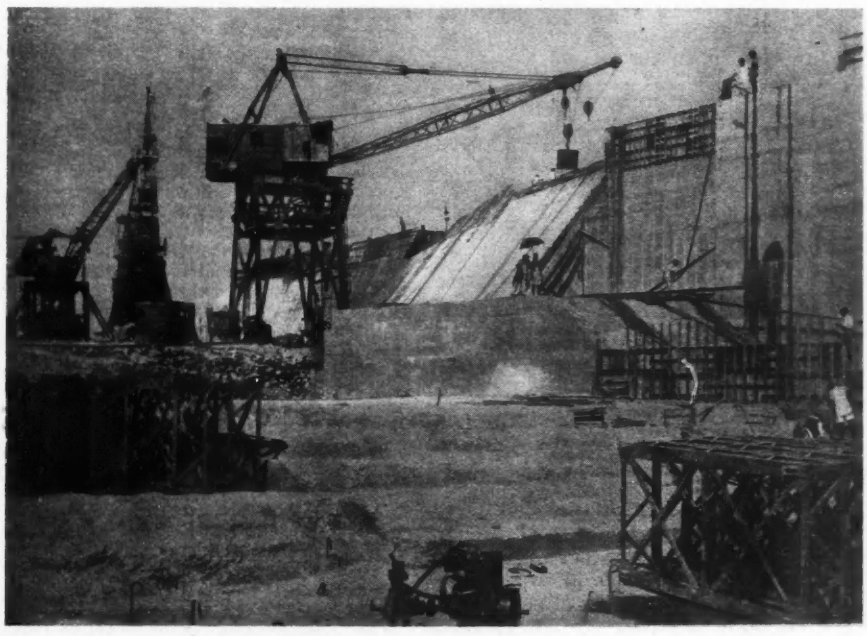


Fig. 10—Concreting the Left Flank Wall

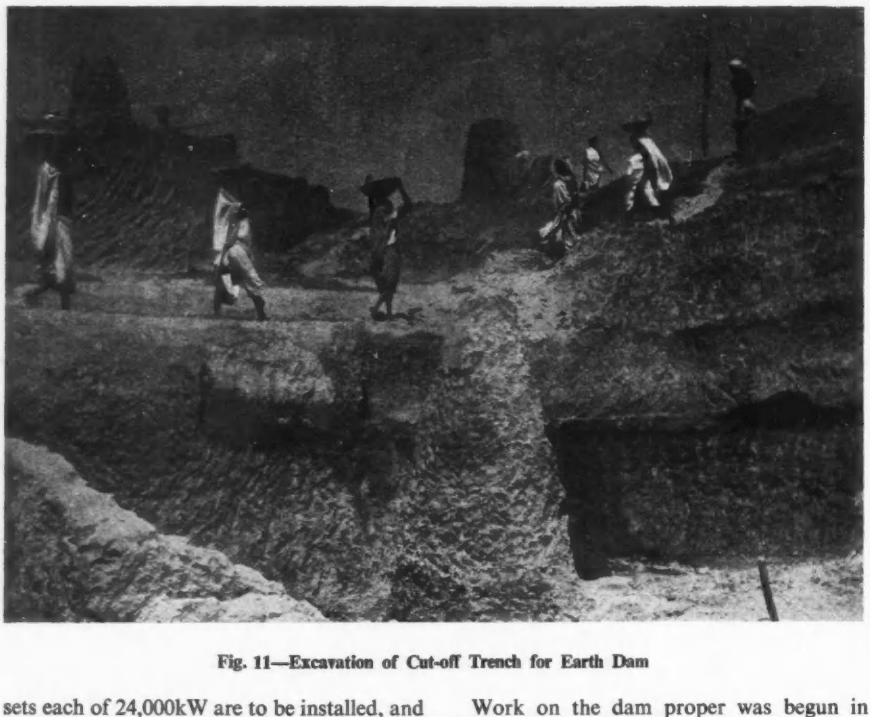


Fig. 11—Excavation of Cut-off Trench for Earth Dam

sets each of 24,000kW are to be installed, and these are already on order. Later on, three more sets of 37,500kW will be installed, bringing the total installed capacity to 235,500kW. The firm capacity will, however, only be 123,000kW, consisting of two 24,000kW and two 37,500kW sets. Of the remaining three, one will serve as a standby and the other two to deliver secondary power during monsoon.

The power station at the subsidiary dam, temporarily postponed, is designed to have four main generating units, each rated at 24,000kW, the turbines being rated at 34,100 b.h.p. at 75ft head. Power from both the stations will be transmitted to Cuttack, capital of Orissa, through a 132kV single-circuit line and also supplied to aluminium, ferro-manganese and steel industries to be set up in the state in the near future.

A general plan of the power station is given in Fig. 7. The station is divided into a number of bays. Starting with the 100ft long service bay at the right-hand end, the initial construction of the station will be limited to five bays. Ultimately it will have eight bays in all—seven bays for the seven generating units and one service bay. The generating sets Nos. I and II, housed in the bays adjacent to the service bay, will be 37,500kW feathering propeller type, Kaplan turbine-driven units, manufactured by the English Electric Company, Ltd. The next bays will house two 24,000kW generators, driven by Francis turbines. The turbines are being manufactured by J. M. Voith and the generators by Siemens Schuckert Werke. The Kaplan turbines are rated at 52,000 b.h.p. and the Francis turbines at 34,500 b.h.p. The remaining three bays will house 37,500kW units, but these will not be required for some time. Fig. 5 shows the section through the second 37,500kW unit.

Cost and Progress

The estimated cost of the entire project is Rs. 92·08 crores, but as the demand for power is not likely to develop immediately, the phasing of the programme of construction and expenditure is spread over twenty years. The stages as accepted by the Hirakud Advisory Committee are as shown in the table on page 831.

Work on the dam proper was begun in 1948 and is proceeding well. The work, however, has suffered on account of financial stringency and also inexperience in executing a project of this magnitude. The project has been revised several times and has come in for a lot of criticism, resulting in the appointment of an inquiry commission, whose latest report now approved by the Advisory Committee forms the basis of the new revised programme. It is now believed that teething troubles are over and that, barring major breakdowns, a steady progress will be maintained in future. Already a new cement factory with a capacity of 150,000 tons of cement per year has gone into production and is expected to facilitate the construction of the concrete dam and other concrete works. Most of the earth-moving machinery is now on site, and attempts are being made to obtain more through the offices of the T.C.A. A fully equipped workshop has been established and is manufacturing such items as sheep's foot rollers, 3-cubic-yard concrete buckets, belt conveyors and screens. A batching plant with a capacity of 60,000 cubic feet per day has been installed and another one with a capacity of 40,000 cubic feet per day capacity is being erected. However, although the difficulties due to inadequacy of heavy machinery are slowly being overcome, the latest progress report makes a pointed reference to another grave handicap—the shortage of qualified and experienced men. The report says : "The mechanical officers on this project, both executive and assistant engineers, are leaving the project to take up appointments on other jobs on higher salary. This drift is seriously affecting the progress . . . and, unless checked in time, the work is bound to suffer."

The following table sums up the progress position up to June 30, 1953 :—

Item	Estimated quantity, cubic feet	Completed quantity, cubic feet	Work done per cent.
Concrete dam :			
Excavation, common and rock	23,274,000	20,337,000	87
Concreting and masonry	39,500,000	8,355,928	21·2
Earth dam :			
Excavation	11,700,000	8,050,000	68·5
Earthwork	460,400,000	130,486,000	28·2
Rockfill riprap	47,260,000	17,452,000	36·9
Dykes :			
Earthwork	256,163,000	90,244,000	35·2
Stone protection ...	29,519,000	9,630,322	32·2
Canals :			
Earthwork, main canals	499,685,000	311,850,000	62·4
Earthwork, distributaries	260,000,000	48,707,000	18·7

Problems of Aircraft Production

THE second conference to be arranged by the Institution of Production Engineers on Problems of Aircraft Production was held last Friday and Saturday at the University of Southampton, Highfield, Southampton. Like the first conference, which was held last year, its object was to bring together the designers the production engineers and the users in order that their requirements which are so often incompatible could be reconciled.

In the afternoon session, Friday, December 18th, the problems discussed were those of the airframe designer on a theme entitled "The Trend of Design," following a paper by D. Keith-Lucas, chief designer of Short Brothers and Harland, Ltd. After tea the evening session was devoted to a theme "Production Problems Arising from the Trend of Design," in which two papers were presented for discussion and abstracts of one of them are reproduced below.

The conference was concluded on Saturday morning with a discussion on "The User Problems Affecting the Industry," in which the principal speakers were Air Marshal Sir R. Owen Jones, Controller of Engineering and Equipment, Air Ministry, and B. S. Shenstone, chief engineer, British European Airways Corporation. The conference was summed up by Sir Frederick Handley Page.

The following abstract is from the paper entitled "Cheaper Machining Methods," by G. H. Dowty, chairman and managing director, Dowty Equipment, Ltd.

The challenge which we now have to face is that of cheaper machining methods. It should be possible to adapt the ease, cheapness and versatility of the router technique to the problems of skin milling. The chief trouble in this case is one of obtaining an increase in accuracy, for skin thickness limits, at least as small as those which obtain on rolled plate, have to be maintained. I will show some slides later which illustrate possibilities in the use of the router technique for skin milling.

The production engineer must look far enough ahead to ensure that the tools necessary for any particular job are available in the factory in time to meet production requirements. In the case of the new techniques capital outlay can be very large.

This places the engineer in a difficult position, in that it is possible that the design requirements which we are discussing may last for a very short time only, and then be superseded by some turn of events entirely beyond his control.

What I have especially in mind is this : America is producing large skin milling machines for the purpose of manufacturing integrally machined sections. Some of these machines cost around £100,000 to £150,000.

In order to meet an aircraft production programme, two or even more of these machines might be necessary. Such a capital outlay for short-term production, which might end as soon as the increase in aircraft speeds makes it necessary to change to steel or titanium, poses a problem.

This is one of the difficulties facing the production engineer who has to recommend large capital expenditure on plant, knowing that design trend is not completely stabilised. However, the machining of integrally stiffened skins and large forgings is with us for the next breed of aircraft, and methods must be found which will enable

us to produce them. I believe that some simple solution will be found.

Problems Involved—Machines

The decrease in the thickness of wing sections, combined with the severe stresses imposed on aircraft in supersonic flight, has made the heavy structural member indispensable. A member which is made in one piece is stronger and lighter than one fashioned from an assembly of many pieces, whilst, because of its better grain flow, a forged member is stronger than one machined from a solid billet.

The trend is towards the use of large one-piece members, machined to close tolerances to conserve weight. We are, at the present time, tending to spend too long in cutting these members from solid billets of material. Much of this time could be saved if a really large forging press were available to the industry. It is possible for us to produce a limited quantity of aircraft from components machined from solid slabs of light alloy, weighing a ton or more, but large-scale production cannot be sustained in this way.

If the large forging press were available, design technique would immediately avail itself of it, because of the benefits to be gained from the higher strength which results from correct grain flows, and the reduction of heat-treatment problems. Designers are unwilling to create designs calling for large forgings unless the capacity exists to make them. Conversely, industry waits for the need to be created before provisioning the tools to satisfy that need. This vicious circle must somehow be broken.

Large Forging Presses

The American aircraft industry has laid down an extensive programme for the manufacture of large forging presses. The large forging press was first used as a production tool by the German aircraft industry during the last war. A press of 15,000 tons capacity was in use before the war, and eventually they constructed one of 33,000 tons capacity.

At the end of the war the Americans were able to secure the German press of 15,000 tons, whilst the 33,000-ton press was seized by the Russians. The American programme caters for further presses of 35,000 tons and 50,000 tons capacity. In this country, we have no forging press as large as those in America, and, so far as I know, bigger ones are not projected. This seriously limits the size of forgings which can be produced, and makes it necessary for us to machine our large components from extremely large billets of light alloy. This wastes both material and machine capacity, and if the present trend in design continues, it is imperative that we have presses installed in this country of not less than 35,000 tons capacity, and, better still, of 50,000 tons.

In order to obtain the maximum advantage from the use of large forging presses, a forging technique should be developed, capable of producing "close to limit" forgings, having the minimum amount of material to machine off to produce the finished component. This technique will necessitate the use of a succession of progressive dies to produce the forging, each die bringing the material nearer to the required form.

It may be that the production capacity of the forging presses will not enable us to exploit this technique to the full, but an endeavour should be made to do this on the most complicated parts. Because of the necessity to use a close weight control on all aircraft parts, it has been found necessary to machine most components all over, as the limits on forgings give a wide variation on the finished weight of the component if this is not done.

This is a forging manufacturer's problem, and it is aggravated by the fact that quantities of an individual forging are comparatively small. This means that the forging manufacturer must have a large tool room, with costly die sinking equipment. As he usually sells his products by weight, it will be difficult to sell him the idea of "close to limit" forgings on a small forging programme.

However, from a national point of view, it would be far better if the copy mills, which are now employed in the aircraft industry for component machining, and, in so doing, making tons of light alloy swarf, were to be employed in making the dies for the forging presses.

Having once made the dies, all the necessary heavy machining on the components would be largely eliminated, and the result would be a great saving in man-hours.

The forging press and its ancillary equipment is extremely costly. The American forging press of 35,000 tons capacity weighs approximately 9000 tons, and measures 108ft overall. I am informed that the cost of such a press is about £250 per ton, which means that total cost would be around £2,250,000.

This would not represent the total expenditure involved, as the press has to be housed, served by furnaces, heat-treatment plant and other ancillaries. The saving in machine-hours which result from production of "close to limit" forgings is vitally necessary to render the expenditure of such vast sums economic.

Copy Machining

Copy machining has, of recent years, become the best tool in the hands of the production engineer, both for milling and turning. Such machines are being increasingly developed, and the end may well be the completely automatic factory. Copy machines are to-day largely hydraulic, but a few are controlled electronically. Electronics may, in the future, allow a machine operation to be controlled by magnetic tape, punched cards, or even by a computor which is continually working out the position of the cutter from drawing ordinates. There is a wide field for research here.

In the machining of such components as fuselage frames, wing ribs, &c., from large forgings, or even from billets, there are problems involved which, at the moment, cannot be met by existing copy mill techniques. Not only is it necessary to control the cutter around 360 deg. in the flat plane, combined with control in the vertical direction, but it is also necessary to control the cutter on its axis, in order to provide the machining of external and internal bevels.

This means machine control in three dimensions, combined with axial control of the cutter head in the two vertical planes. I believe that no such machine has yet been built. An American tool firm is building such a machine, which they call the variable axis ("Variax") with copy control in each of these five movements.

At the present moment it is intended that this machine shall be controlled by steel templates and electronic tracers. Its capacity will enable it to machine a component up to 12ft long and 3ft wide. It is the manufacturer's intention to develop this machine so as to make the use of templates unnecessary. Numerical information will be fed into a computing device, which will produce a punched tape. This is later transferred to a magnetic tape, which will be used to control the movements of the machine to produce the finished form on the component.

This machine will reduce the number of tools required to produce a machined part to the minimum. It will be extremely flexible as new instructions to the machine, in the form of magnetic tape, can be quickly and easily produced. The machine will have an electronic memory, and instructions, which may be fed into the machine by hand, template or from numerical information, will be recorded on a tape which can afterwards be "played back" to reproduce exactly the required movements of the machine. For the machining of bevelled and angled machine parts, I believe that this type of machine will be the most simple which can be used.

Skin Milling

With regard to the specialised machine tool which will be necessary to provide for the purpose of skin milling, the case is somewhat different. The problem is twofold: first, technical, i.e. ways and means, and then quantitative; the provision of a sufficient number of machine-hours to produce the programme.

At the moment the integral milling trend in America seems to be towards the production of skins having stiffeners which are parallel to one another. On the other hand, the trend in this country calls for a wide variation of reliefs, stiffeners and rebates. Most designers have a different approach to the integral technique, and what is required is a machine, fitted with both vertical and horizontal milling heads, capable of copy milling in three dimensions. At the present, the choice of large machines to do this function is extremely limited. I know of no one machine that will machine skins with converging integral stiffeners, combined with a tapering basic skin, pockets forming thickness reliefs on the least highly stressed parts of the skin and all manner of rebates.

A good deal of experience has been gained in the holding of sheet metal while it is being machined. The most usual method is to hold it on to a surface by air pressure by the use of a vacuum chuck. A vacuum chuck is a machined surface, bearing a seal around its outer edge, and provided with means whereby the air can be withdrawn from underneath any sheet of metal placed on the top surface. Excellent vacuum pumps are now available, and they are both reliable and cheap. A reservoir should always be interposed between the vacuum and the chuck, as, in order to pull the sheet into contact with a chuck surface, it is necessary to provide a sudden surge of variation of pressures. This is obtained by exhausting the reservoir by the vacuum pump and suddenly opening the valve connecting the reservoir to the vacuum chuck. Sheets which are slightly distorted can be pulled into perfect contact with the vacuum chucks by the use of this technique.

With the continuation of the integral technique, development will take place along the lines of the American skin milling machines, which will result in a reduction of their cost and increase their range and versatility.

If the integral technique is carried to its logical conclusion, whereby a wing is formed in two halves from large forgings or solid billets, then another type of machine will be needed. This will be required to machine the external contours of wing surfaces. In this case the cutter must be presented tangentially to the surface of the material in order to generate the aerofoil curve.

I envisage such a machine as having two tables, one at either side of the machine, at the centre of which is a moving carriage containing the cutter head and the tracing mechanism. On the rear table will be mounted the master form, over which the tracer will operate and control the cutter which machines the component mounted on the worktable at the front of the machine. There are a number of variations of this machine being developed at the present time by several firms.

Future Developments

The continuing developments of the technique of machine control from numerical information will almost certainly extend to such a machine for the machining of external contours. The cutter head will follow a path determined by a computor, which works out its position from X and Y ordinates. I also believe that further simplification of skin milling machines will take place as development progresses, in so far as it will be possible to machine rebates, reliefs, integral stiffening, and so on, direct from a drawing, by using an electronic eye.

With the inevitable introduction of steel into the manufacture of airframes, problems will arise in the machining of high-tensile steels. In order to achieve the best strength/weight ratio, these steels will be in the neighbourhood of 100 tons tensile.

Here the problem lies in the provision of cutters, in increasing cutter life, and in decreasing the cutting time. Because of the extreme toughness of the steel the finish obtained is generally poor. However, such steels are notch sensitive, and a fine finish must be obtained to remove stress raisers. There is immediate need for an investigation into the machining of high-tensile steels. The use of carbon dioxide as a cutter coolant may increase the cutter life and improve the finish. The Americans have used high-pressure oil jets at the cutting edge.

Finishing of Components

The high strength light alloys which we are now using are extremely notch sensitive, and it is therefore necessary to produce components with surfaces free from machine marks and scratches.

Formerly, components were finished by hand dressing and the use of power tools, in the form of flexible polishing equipment and polishing

LOAD TEST PLANT FOR LARGE ALTERNATORS

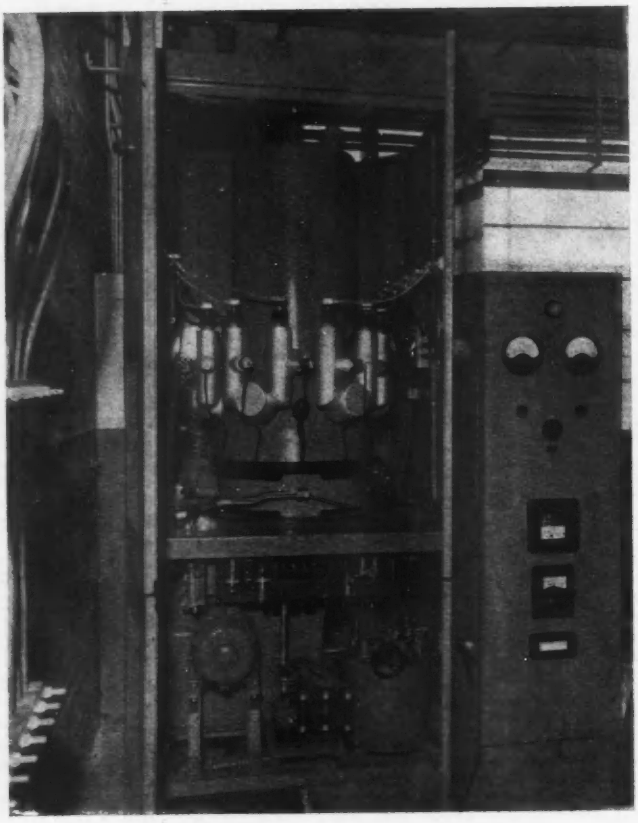


Fig. 1—Grid-Controlled Rectifier for D.C. Excitation of Reactors

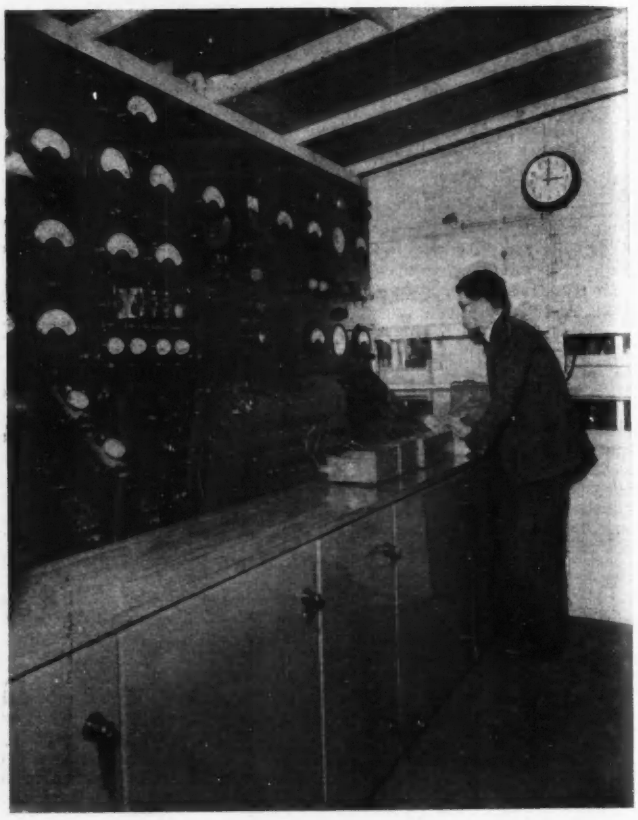


Fig. 2—Control Room

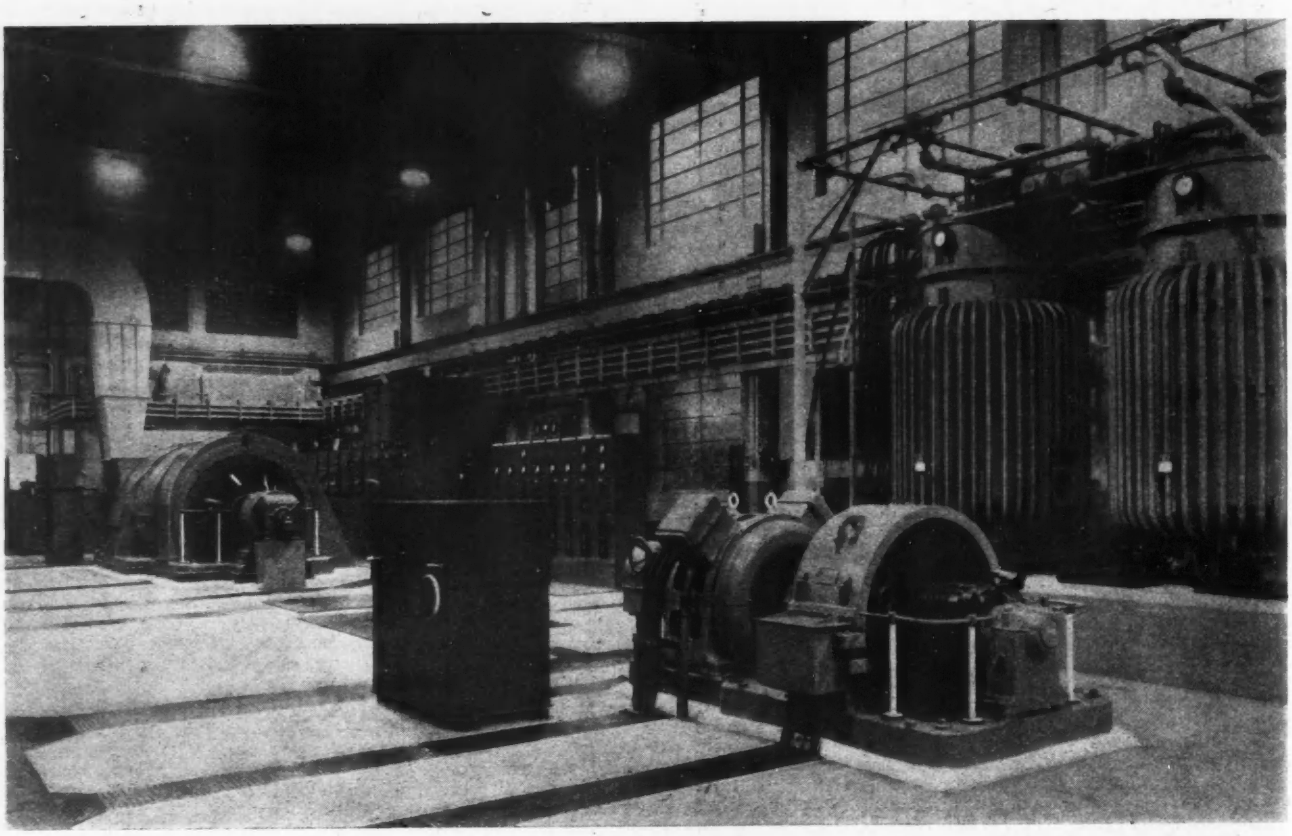


Fig. 3—Interior of Test Substation

lathes. Such methods were extremely costly in man-hours, and it became necessary to find other methods. A solution lay in the use of the barrelling technique. By this method the components are placed in a large rubber-lined, cast iron or welded drum, together with limestone chippings, water and a foaming agent. The drum is then rotated for a period of hours, during which time the surface is worked upon by the chippings as they pass to and fro across the components. All machine marks are removed and a finish, better than 14 micro-inches, is consistently obtained.

Components are now barrelled six at a time, and the process is completed in twelve hours. It must be remembered that this is an entirely mechanical process, in which no operator is involved during the time that the machine is working. Some 500 of the smaller components can be placed in the barrel at the same time, and the time taken to finish them is five hours.

Another method of removing such marks on components is by the vapour blast process. In this machine the components are subjected to a jet of water under pressure, into which is injected fine abrasive particles by means of compressed air. The jet can be manipulated by means of a gun held by an operator, and any portion of the component can be worked upon to a greater or lesser extent, according to the basic surface finish. The finish obtained by this process is not so fine as that obtained by barrelling ; it is around 40 micro-inches, but fatigue specimens indicate that a satisfactory reduction in notch sensitivity is obtained.

The steel fittings which we use to-day are of 90 tons tensile and over, and a poor finish is obtained in view of this hardness. These, too, have to be polished to remove marks, but so far, owing to the unsatisfactory basic finish, and the extreme hardness of the material, barrel finishing or vapour blasting has not proved to be successful. The problem should be investigated and electro-polishing may prove to be the solution. Electro-polishing is a cathodic method of metal removal, which attacks high spots first of all, thus smoothing the surface.

But any successful method of mechanical polishing does not relieve the machine shop of the responsibility of obtaining the best possible basic finish, and there are problems to be solved here. These are to obtain better cutter life, and therefore better finish by greater rigidity of fixtures and machines, by investigation into the use of carbon dioxide as a cutter coolant, or the high-pressure oil jet to the same end ; better cutter grinding methods to ensure concentric cutting teeth, and elimination of grinding marks, perhaps by vapour blasting of the teeth.

Summing Up

I am concerned about the fluidity of design thought at the moment and its effect on the future production of tools to do the job. If the future lies in titanium or steel, it is useless our obtaining expensive skin milling machines for the purpose of machining integral structures. When these are developed to the point at which they become useful tools, the need for them may have disappeared or, at best, they may have only a short production usefulness before the method is superseded. On the other hand, the production tools which we are using at the moment are going to continue to be of use to us when steel needs to be machined.

The Cincinnati " Hydrotel " copy milling machine is an extremely useful tool, enabling us to machine complicated profiles and contours with the use of inexpensive templates. Whatever may be the outcome of present design trends, this type of machine will always be of value.

Not everyone can afford lines of these expensive and scarce machine tools, but most factories have both vertical and horizontal mills. These can be adapted to carry out simple profiling operations.

We must seek short cuts and aids to production if the costs are not to rise still further. This increase has been spectacular. In the second world war a fighter airframe took from 4500 to 10,000 man-hours to build. The equivalent aircraft to-day takes from 30,000 to 40,000 hours. I believe that we have now reached the peak in the number of man-hours taken to build an aircraft, and that with new methods we shall see a levelling off and a decline.

Load Test Plant for Large Alternators

A test plant using saturable reactors for applying the equivalent of full load at zero power factor on large alternators is installed at the Witton works of The General Electric Company, Ltd. This loading plant is intended for testing prototype machines rather than for routine test work. A brief outline of the test equipment is given here.

ON a recent visit to the Witton works of The General Electric Company, we attended a demonstration of a new test plant in which saturable reactors are used to simulate full-load test conditions on large alternators. Normally the main difficulties of direct load testing large generators in the works are those of providing a prime mover of the required power and of absorbing the output of the machine. The object of the new test equipment is to reduce the actual power involved, by using saturable reactors to load the generator on test, up to the full rated current and voltage at approximately zero power factor. The impedance of these reactors are continuously variable between wide limits to cater for machines of different sizes and voltages. The test plant is believed to be the first of its kind in service. It is intended for development and research work in connection with future designs and will not normally be used for routine tests.

In the equipment which we saw demonstrated, saturable reactors provide a wattless load which can be controlled over an extremely wide range by varying the d.c. excitation of the reactor cores. Without d.c. excitation the reactors absorb only 500kVA. With d.c. excitation very smooth control is available from this low figure up to 100MVA. By rearrangement of a system of external flexible links the reactors can provide maximum loads of 75,000kVA at 11kV and 22kV or 37,000kVA at 6·6kV. For the demonstration a 60MVA hydrogen cooled alternator (for Uskmouth power station) was loaded up to 100MVA, the hydrogen for cooling being at 15 lb per square inch instead of the normal 0·5 lb per square inch. This alternator can be seen on the left of Fig. 5.

As illustrated in Fig. 4, the reactors are installed in an open substation adjoining the test substation which is housed in the main building. There are two reactors and they are arranged for forced oil cooling. Each reactor has two forced draught oil coolers with integral fans, the coolers being mounted alongside the associated reactor, as shown in Fig. 4. Each reactor has a six-limbed core with tertiary windings so arranged that the current taken from the alternator undergoing test is practically sinusoidal. We learn that tests taken on the equipment have shown that the waveform has a maximum harmonic content of 1½ per cent.

Direct-current excitation is provided by a twelve-phased grid-controlled rectifier of pumpless steel tank form, the output voltage of which can be varied to meet the required conditions of excitation. This rectifier (Fig. 1), which is housed inside the substation, is fed from the 11kV works supply through a 750kVA outdoor transformer.

The a.c. output from the alternator on test is conveyed to the reactors by tubular copper busbars, which have a normal capacity of 6000A and are insulated for 30kV working. The alternator is solidly connected to the reactors, fault protection being arranged to trip the excitation both of the alternator and the reactors, thus making the a.c. circuit dead.

The combined raised test bed is so arranged that one machine can be erected or dismantled while a second is on test. This facility is clearly illustrated in Fig. 5, from which it will be seen that the driving motor is mounted on a central platform and can be coupled up to machines erected on either side of this platform.

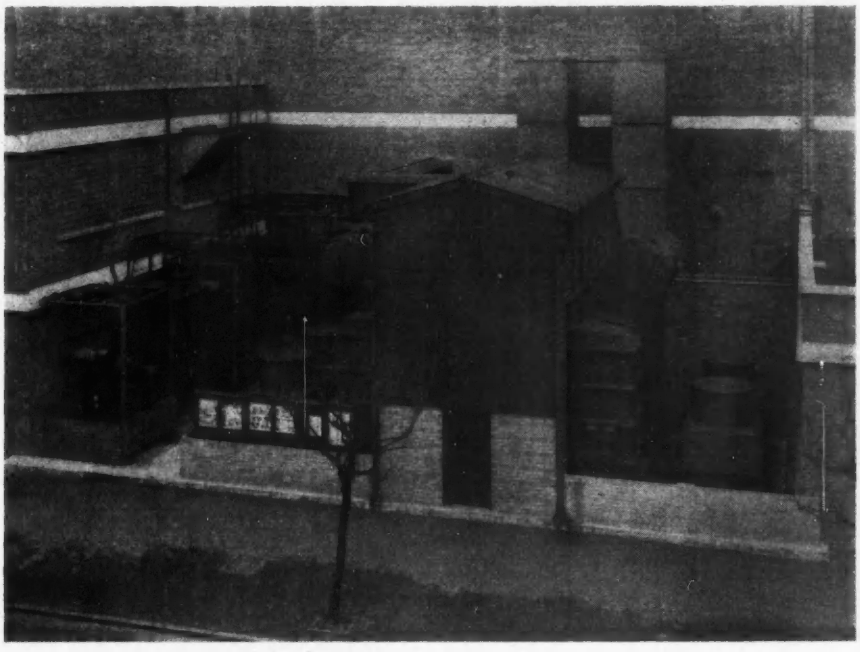


Fig. 4—Reactors and Power Transformers in Outdoor Substation

Each bed is equipped with a closed circuit ventilation system for either air or hydrogen cooling and is arranged to support the stators and rotors of steam turbine-driven alternators ranging in output from 12MW to 200MW. As the alternator is erected on the test bed independently of its foundation plates, foundation work on site can proceed simultaneously with the testing of the machine.

A 3000 h.p. two-pole induction motor drives the alternator and supplies all losses. It is powered from the 11kV incoming supply through a step-down transformer and two induction regulators and is controlled by a large remotely-operated liquid controller. With this equipment a 60MW machine can be run up to speed in about five minutes and shut down in four minutes.

For very large alternators additional power can be obtained by coupling a second motor in tandem.

The precautions taken against lubrication failure are interesting. Oil for the bearings and hydrogen seal is fed from a 2500-gallon reservoir, in which the oil is under an air pressure of 60 lb per square inch. This pressure and the flow of oil are maintained by screw pumps, which are independently driven by squirrel-cage motors. In the event of a failure of the electric supply the motors are automatically switched over to a separate emergency supply. Should this supply also fail, or the pumps themselves break down, the capacity of the reservoir is adequate to permit a large alternator to be brought to rest in safety.

Heat generated in the alternator and in its bearings is dissipated in water coolers. As the volume of cooling water may approach 2000 gallons per minute a closed water circuit is adopted, the water itself being cooled in forced draught spray coolers before being recirculated. In the case of hydrogen-cooled alternators the coolers are built into the machines, but for air-cooled alternators a separate test cooler is used, and the two spray cooling towers can be seen in the background of Fig. 4.

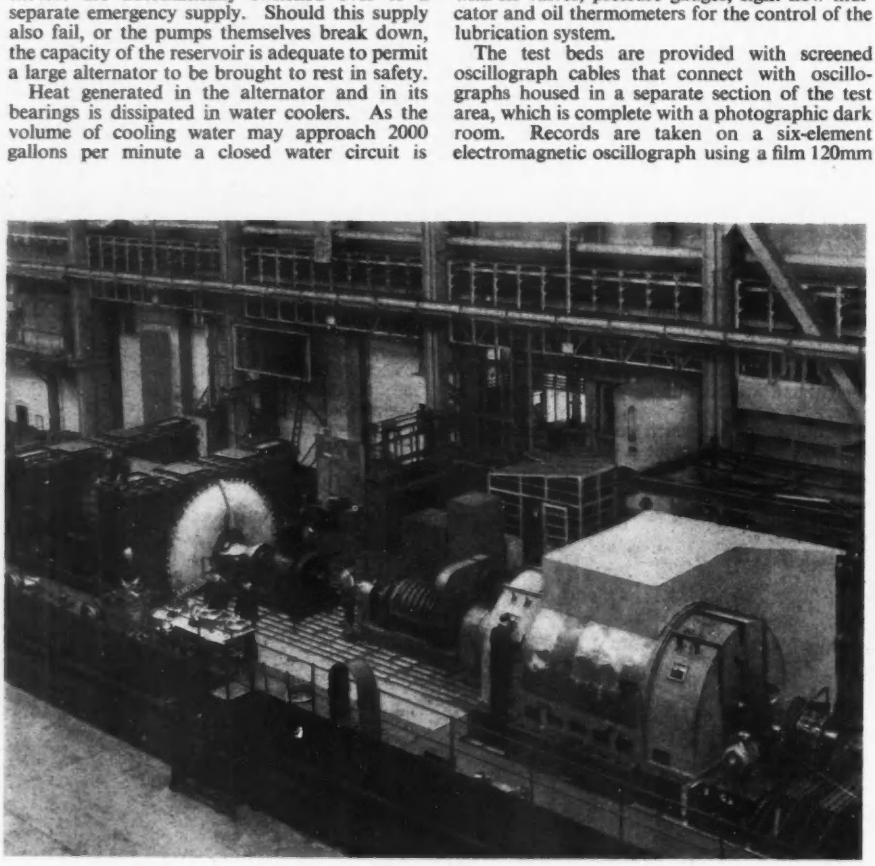


Fig. 5—Alternator Test Bed

For test purposes the hydrogen control is entirely manual and is kept as simple as possible, the instruments comprising a purity meter, pressure gauge and an inclined U-tube oil gauge, which indicates the fan pressure and also serves as a purity indicator.

Next to the test beds is the substation (Fig. 3), which houses the power plant and 11kV and 440V a.c. switchgear and 460V d.c. switchboard. The power plant includes a motor generator set, which comprises (background, left) a 2000kW d.c. generator, a 4000kVA synchronous machine and a 750 h.p. synchronous induction motor. Also in the substation are a 400kW exciter set (foreground), the two induction regulators (right) which control the supply voltage to the driving motor of the alternator on test, and the grid-controlled rectifier for the excitation of the saturable reactors. Next to the motor generator set there is, as can be seen from our illustration, space for a further rotary set.

The adjoining outdoor substation accommodates all the associated transformers, reactors and water cooling apparatus.

The tester in charge operates in a central control room (Fig. 2), in which all the test and auxiliary instruments are situated. On one side of the room is a control board, which has permanent metering for the driving motor circuit, and ammeters in the circuits of every essential auxiliary together with the usual alarm warnings which indicate the failure of any essential circuit. All measurements relating to the alternator under test are effected by portable substandard instruments, while 48-point and 12-point temperature indicators give readings from the normal embedded temperature detectors and additional temporary test thermocouples. Facing the control board, and along the opposite side of the control room, is the lubrication panel with its valves, pressure gauges, sight flow indicator and oil thermometers for the control of the lubrication system.

The test beds are provided with screened oscillograph cables that connect with oscillographs housed in a separate section of the test area, which is complete with a photographic dark room. Records are taken on a six-element electromagnetic oscillograph using a film 120mm wide by 320mm long. Alternative arrangements permit the use of a continuous film for measuring transients or where records over longer periods are required.

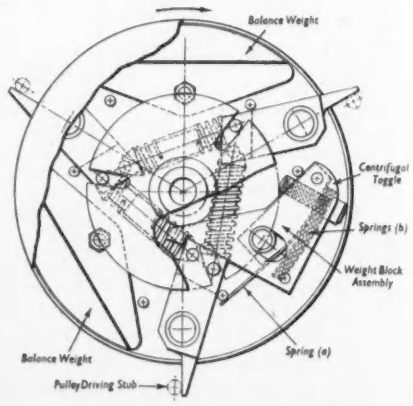
Mechanical Torque Trip Unit

In the course of development work on a project undertaken by Tiltman Langley Laboratories, a mechanical torque trip unit, illustrated here, was developed to fulfil the requirements of a particular rig. It was necessary that the device should trip at a limiting torque setting according to the spring rates selected in the design and be easily and simply recocked. The unit had also to be prevented from tripping under starting torques, duly recognising the safe mechanical limits of the mechanism.

The trip assembly shown is keyed to the motor shaft and the drive is transmitted through the three levers to concentric pillars mounted from the pulley disc which is not shown in our illustration. This disc is otherwise free to rotate upon the trip assembly and is axially located by a "Circlip." The levers are pivoted to the keyed assembly and their inner ends are interconnected by telescoping links around each of which a coil spring is located.

In operation the freedom of the levers to pivot is resisted by the coil springs in compression. Owing to the arrangement of the linkage the system operates about a dead centre position with the levers pivoting in one direction. Compression of the springs proceeds up to the dead centre position, until when the levers maintain contact with the pulley pillars. Thereafter the linkage being free to extend and the spring to expand, the levers are forced to pivot through a further arc such that they no longer reach the pulley pillars. They can then be recocked by simply turning the knob of a cocking plate which engages in slots one hinge pin of each lever.

In order that the drive shall not be severed during the period of relatively high starting torques a centrifugal toggle is incorporated. It is asymmetrically weighted about its pivot so that under normal speeds the toggle swings clear of the tripping arc of the lever, against the resistance of the strip spring (*a*). In the event of starting on low speed torques liable to damage the trip unit, the toggle can be displaced in a near-radial manner in its slot, by the lever engaging against a step in the heel of the toggle. This displacement is governed by the springs (*b*).



Mechanical Torque Trip Assembly

Short Notices

Static Electrification. London : The Institute of Physics, 47, Belgrave Square, S.W.1. Price 25s.—A symposium dealing with all aspects of static electrification was organised by the Institute of Physics and was held at Bedford College, London, in March, 1953. The proceedings of this symposium have now been published as a supplement to the *British Journal of Applied Physics*, in the form of a book of 104 pages with stiff covers. In this book, as in the original symposium, the papers are grouped under three main headings, concerned, respectively, with general principles of the generation and dissipation of static electricity, useful applications, and harmful effects of static electrification. In addition the book reproduces the introductory lecture on the theory of contact electrification, which was given by Professor F. A. Vick. There is also a group of three papers dealing mainly with machines for the production of high energies and machines capable of generating useful power. A subject index and an author index complete the record of this symposium.

Magnetic Amplifiers. By George M. Ettinger. London : Methuen and Co., Ltd., 36, Essex Street, W.C.2. Price 6s. 6d.—This book is one of Methuen's monographs on physical subjects—a series which is designed to provide science students at university level with a condensed statement of existing knowledge on a given subject. The scope of the book under review is wider than the title might indicate : for it deals with devices ranging from the simpler forms of saturable reactor to high-sensitivity magnetic modulators, with systems using ferro-resonant phenomena and with recent applications of magnetic devices in computing machines. Recognising the importance of magnetic core materials the author has included data on the properties of available materials despite the risk that progress might soon make some of this information out of date. For the benefit of designers of servo systems there is a chapter on transient response. The text is accompanied by a useful bibliography.

Mobile Engineering Radiographic Unit

THE use of radiographic inspection for welded joints in vessels and pipework subjected to strains and stresses in service has been steadily increasing during recent years. The cost of radiographic inspection equipment, however, often makes it impracticable to have it on all erection sites, and for this reason the Power-Gas Corporation, Ltd., and Ashmore Benson Pease and Co., Ltd., of Stockton-on-Tees, introduced a new service with a mobile field engineering radiographic unit. This equipment is self-contained and staffed by qualified personnel and can, when required, provide at remote sites or works the facilities of a fully equipped radiographic department. The unit, which can be seen in one of the illustrations on this page, is built on a standard Commer " Avenger " passenger vehicle chassis.

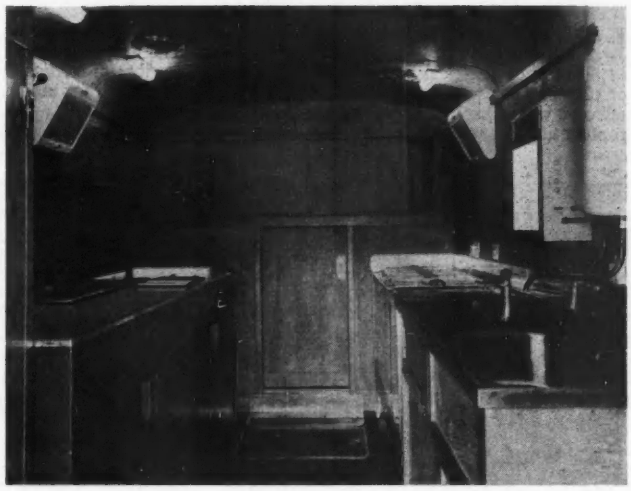
Various methods and equipment are available for such work as chemical pipework, storage tanks, gasholders, pressure vessels, bridges, and castings, and they can be selected according to the nature of the structure. For example, if radioactive isotopes are being used iridium 192 is selected for small pressure vessels, chemical and pressure welded pipelines with a thickness range of ⅛in to 1½in and ½in to 36in diameter ; thulium 170 is used for aluminium and light alloys in general, and cobalt 60 is used on exceptionally heavy gauge work where, if other methods were used, the exposure times would be prohibitive. The X-ray equipment carried have a range from 150kV to 300kV, and are used mainly for extensive work being inspected to satisfy Lloyd's Class 1 requirements.

With this service, as soon as a film has been exposed, and each exposure has been marked by means of lead letters and numerals so that a permanent record is kept of each weld radiographed, it is processed in a dark-room which occupies just over half of the available vehicle body space. This dark-room is fully equipped with a processing unit, drying cabinet, work bench, cupboards, cassett racks, stainless steel sink and draining board, and a 1½-gallon water heater. Three water taps are provided, one hot and two cold, and when they are turned on a 24V centrifugal pump starts up and supplies water to the system from a 42-gallon storage tank built into the chassis drop frame. Waste water is collected in a 15-gallon tank on the offside of the vehicle, and tight-fitting stainless steel lids on the tanks make it unnecessary to drain the processing unit every time the vehicle moves. A second centrifugal pump acts as a recirculating pump for the rinsing water.

The compact arrangement of this dark-room can be seen in one of the illustrations. It is completely dust and light proof, and to assist the radiographers an air-conditioning system has been installed which allows them to control the temperature in the room.

The air-conditioning unit is a Smiths 8kW fresh-air, hot-water heater positioned under the dark-room floor. Fresh air is drawn from outside through a replaceable air filter which allows a maximum air flow of 300 cubic feet per minute. The hot water is supplied by placing the heat exchanger parallel to the radiator of the engine of the unit's generating set.

Mobile Radiographic Unit

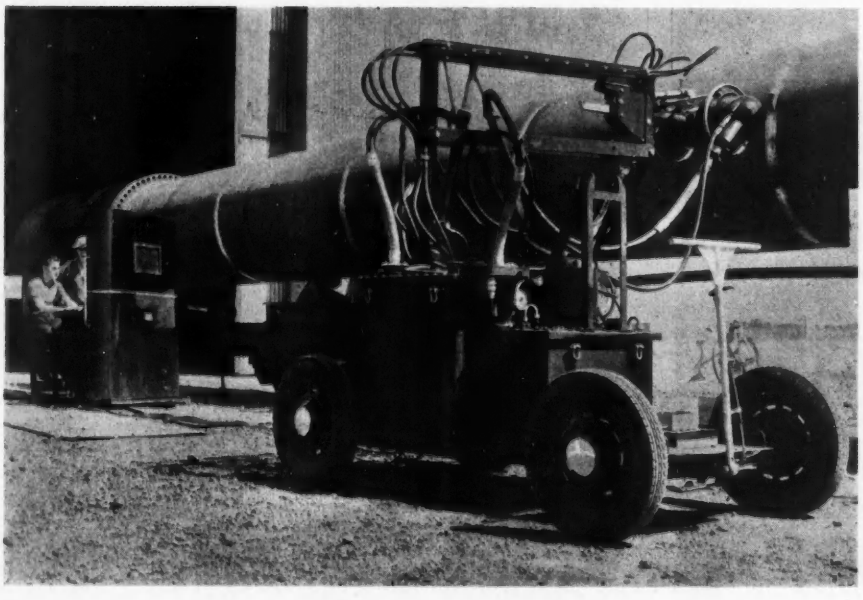


Dark-Room

The rear part of the body is used to carry the X- and gamma-ray equipment when the unit is in transit, and this section is converted into an office and inspection room on site. It is fitted with folding tables which let down into the wall when not required, folding chairs which are stored in a cavity above the driver's cab, and specially shaped filing cabinets which fit into cant roof lockers with sliding doors. The principal item of the gamma and X-ray equipment is mounted on a wheeled chassis as shown in the accompanying illustration. It is loaded into the vehicle through the light alloy rear door and during transit is secured by four stout lashing rings screwed into the floor at each corner.

The radioactive isotopes in their protective lead and tungsten-lined containers are stored in two cavities built on the drop-frame extension and are accessible from the office through trap doors in the floor. The office and dark room are divided by sliding doors which can be locked independently on the dark room side.

The self-contained mobile 300kVp X-ray equipment was supplied by Pantak, Ltd., of Slough, and is designed for heavy industrial use where the apparatus has to be taken to the work requiring examination. It is mounted on a truck fitted with road wheels, brakes and steering gear so that it can negotiate rough ground. The apparatus consists essentially of twin generator tanks supplying the high voltage to the X-ray tube which is mounted in a fully protected shock-proof tube. This X-ray tube is cooled by oil circulated by a pressure pump mounted on the chassis. The tube stand is an integral part of the truck and is designed to give a wide range of movement to the tube. The tube shield can be adjusted longitudinally and rotated in two planes, whilst the complete unit can be rotated through 360 deg. on the truck. All the main movements are actuated by hydraulic rams from a control desk at the end of the



X-Ray Equipment in Operation

truck. This control desk can be removed when the set is in use so that the operator can control the apparatus from a sufficient distance away to be safe from the effects of scattered radiation from the object being X-rayed. The apparatus is suitable for examining steel up to 3in or 4in thick depending on the technique used and the results desired. A 150kVp hollow anode tube can be operated in conjunction with the set using one of the generators and the control desk.

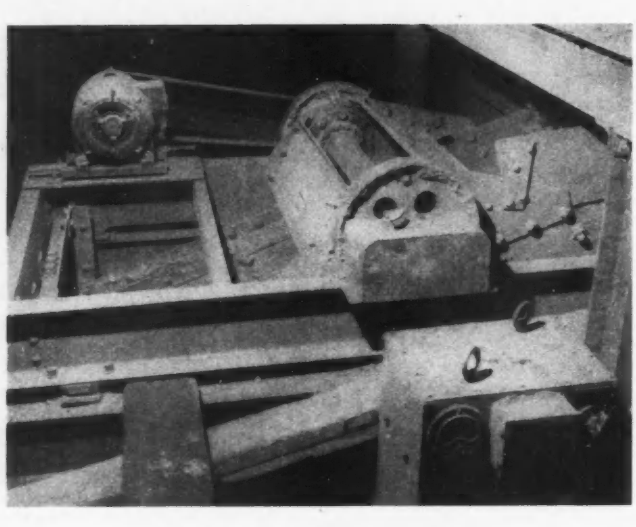
This field engineering radiographic unit can operate on any site even should power and fresh water supplies be inadequate, as it carries its own 24V generating sets in addition to the pressurised water system already described. For the power equipment a sub-frame has been built across the chassis below the dark room to carry a 250Ah "Nife" storage battery, and a 1½kW, 3 b.h.p., 25/35V petrol-electric generating set for charging the accumulators. A master safety switch mounted outside the battery container isolates the 24V batteries.

In an emergency a C.A.V. 24V dynamo mounted under the chassis can be driven by a power take-off, through a shaft and double-vee belt, from the vehicle gearbox. The output of this dynamo is fed through a regulator into the main control panel upon which there is mounted a change-over switch.

Electrically Heated Vibrating Screens in Tile Making

LAST week we visited the Long House Tileries of Henry Hawkins, Ltd., to see an interesting application of electrical heating to the screening of clay in preparation for tile making. In this factory, which has an output of about 500,000 roofing tiles per week, it is the practice to screen the clay in a damp condition, after grinding. The ground clay is taken by a conveyor system to vibrator screens, and the screened material is wet mixed for moulding.

Until recently the screens were unheated and, after about ten minutes' operation, the damp clay used to clog the screen to such an extent that more than 50 per cent of fines were being returned to the grinding plant. Moreover, each screen had to be cleaned manually every ten minutes with wire brushes. To maintain a continuous feed of screened clay there were two sets of vibrators in parallel and one vibrator would be running while the screens on the other were being cleaned. This cleaning process involved increased labour costs, loss of potential output, the replacement cost of screens, and the inconvenience caused by the fact that approximately half of the ground clay was being returned to the grinding mill.



Vibrator Screen and Heater Transformer

Various methods of heating the screens, including that of blowing hot air from fans on to the wire mesh, were tried, but with little success. Promising results were, however, obtained with the help of the Woden Transformer Company, Ltd., Bilston, Staffs, by heating the vibrator screens electrically.

It was found by experiment that the most satisfactory method of heating the mesh was to pass a heavy electric current through the mesh wires at low voltage. The resistance of the wire raises the temperature of the mesh, thus providing a uniform heat over the complete area of the screen. The current rating depends upon the size and mesh of the screen, the temperature of the clay and its moisture content, and to accommodate these variables a tapped transformer was provided giving six different current ratings.

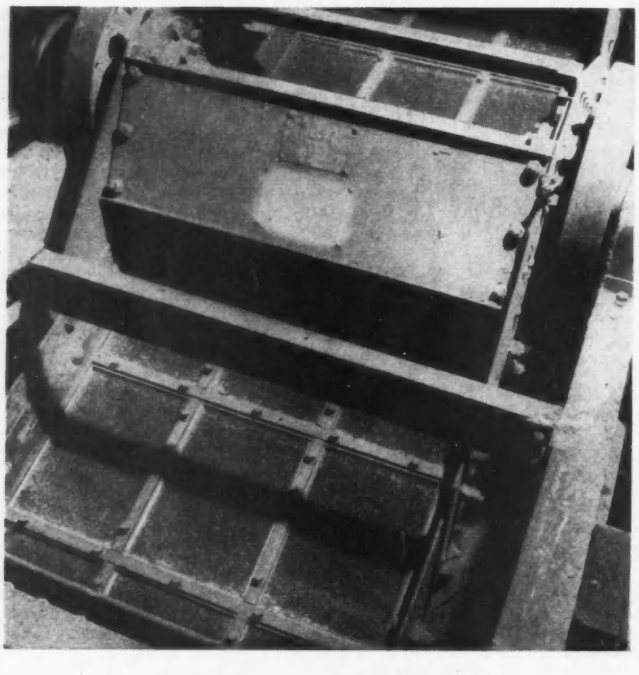
The transformers, which were constructed by Woden Transformer Company, Ltd., are single-phase, air-cooled equipments which have to be totally enclosed because of the fine clay dust generated by the vibration of the screens. The transformers are rated at 12kVA and have class "B" insulation because of ventilation difficulties caused by the necessity for total enclosure. An ammeter is connected in the primary circuit and mounted in the transformer case.

In practice, it is found the tappings on the transformer will cater for a range of meshes on any given screen size, and therefore meshes can be changed if required, without the need for extra equipment.

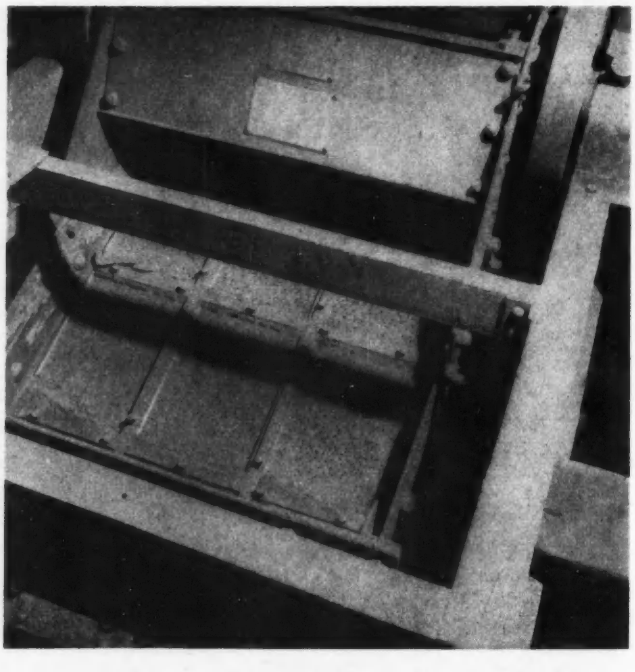
Three views of the installation are reproduced herewith. Our first illustration shows one of the two vibrator screens, with the transformer in the bottom right-hand corner. The second vibrator and its transformer are arranged symmetrically with respect to the central hopper, whence the ground clay is fed to the two screens.

Each vibrator is in two parts—upper and lower—and these parts are fed in parallel from the same transformer. The current is led into the mesh by a number of heavy cables with screwed connections to a copper strap along the bottom edge of each screen, and the circuit is completed by a similar set of cables strapped to the top edge of the screen. The voltage on the screens is of the order of 15V and insulation presented no undue difficulty.

Two of our illustrations show the effect of heating on the screening process. The view on the right shows the clogging effect produced by switching off the heating for about seven or



Normal Appearance of Heated Screen Mesh



Blinding of Screen after Eight Minutes without Heating

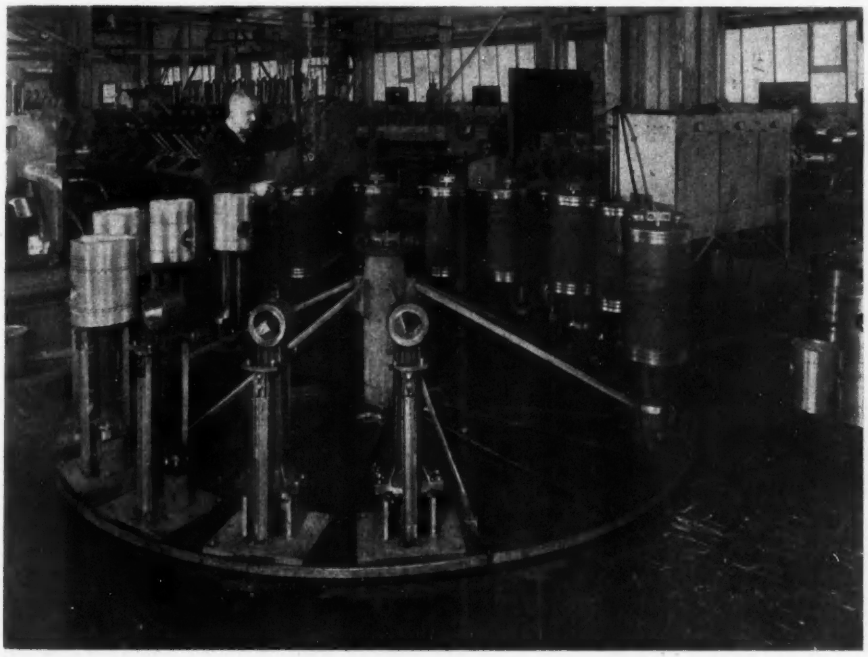
eight minutes. The view on the left shows the absence of clogging on the heated screen. A demonstration during our recent visit showed the effectiveness of the system. Heating was switched off on one of the vibrator screens while the other vibrator was left heated, so that a direct comparison could be made. On the unheated screen clogging began to be noticeable within four minutes and was complete in less than ten minutes. The heated screen remained practically clear as in the left-hand view above.

The electrically heated installation was first operated on a full production basis in August, 1953 : since then manual cleaning has been dispensed with and no screen replacements have been required. We learn that production has been increased by 25 per cent and that the heated screens now pass up to 23 tons per hour.

Modern Assembly Methods

TO-DAY the mass production of engines is made possible by the introduction of line production methods and the track assembly system, but, although careful planning on these lines has reduced working costs, selling price and delivery times, it has not been achieved without having to solve problems on the shop floor. With a range of small engines certain difficulties do not arise, but when a factory is building heavy diesel engines a major problem is that of handling and assembling the larger components within the time allotted at each assembly station along the line. At the works of Mirrlees, Bickerton and Day, Ltd., Stockport, where flow production methods were introduced some time ago, as noted in THE ENGINEER of February 6th this year, this kind of difficulty arose and has been solved by adopting new methods to supersede old processes.

A typical example of just such a problem was that which required solution in connection with the fitting of pistons and connecting-rods into the main cylinder housing of the company's vee



Circular Jig Assembly

form " J " engines, which have a bore of 9½in by 10½in stroke. When servicing this engine in the field the pistons and connecting-rods are removed through the crankcase doors in the cylinder housing and replaced by the same way. This method is not only too slow to be incorporated in the flow production scheme, but prevents other fitting operations from proceeding at the same time. In common with most modern high-speed vee engines, the " J " engine has large-diameter crankpins and the big end of the short stiff connecting-rod will not pass through the cylinder liner and these facts prevent the fitting of the piston and connecting-rod assembly through the top of the cylinder housing with the liners in place. The solution adopted was to fit up the piston, connecting-rod and liner as one unit and to lower each of these assemblies, complete with sealing rings and gasket, into the cylinder housing from the top.

At a specially equipped sub-assembly point the cylinder assembly sets are made up in sets of eight, twelve or sixteen, according to the size of engine required and there are floor-mounted fixtures, to the number of sixteen, which make it easier to make up the cylinder sets for pressure testing the cylinder housing. To reduce engine noise and shock loading on the piston and to keep working clearances to a minimum the gudgeon pin is not fully floating until the piston temperature rises to 150 deg. Fah., and so the pin can only be fitted with the piston at this temperature. Therefore at the sub-assembly point pistons are heated in a thermostatically controlled electric oven and held until required on the assembly jigs, one of which can be seen in our photograph. The connecting-rods are mounted and located at top and bottom in the fixture, which also locates the heated piston so that the gudgeon pin is easily fitted and secured by " Circlips." Next to be fitted are the piston rings, previously checked for gap clearance, and then the piston is sprayed with a graphite oil mixture to provide lubrication of the moving parts during initial starting up of the engine.

After completing a static pressure test at 1500 lb per square inch the cylinder liners are transported to the assembly point along a roller track. They each have a cast iron chamfered ring, clamped to the lower end, the purpose of which is to guide the piston rings into the liner when it is lowered over the piston assembly. This accomplished, the guide rings are removed and liner then rests on two spacer blocks located in the bolt holes in the big end of the connecting-rod. A circular plate fitted over the top end of the liner is pulled down by screwing four set screws into holes, already tapped into the piston crown for this purpose, to clamp the whole assembly together. Except for two rubber water sealing rings and a copper gasket, which are fitted after the assembly is lifted from the jig, the cylinder set is complete.

The sub-assembly point feeds directly to the first station of the main assembly line, where the cylinder housing is fitted with cylinder head studs driven to a controlled torque loading by a pneumatic stud driving equipment. The included angle between the cylinder banks of the " J " engine is 45 deg. and a section of the track is arranged to pivot through half this angle, 22½ deg., to either side of the horizontal to enable the cylinder bores to be swung to the vertical position to receive the cylinder assembly sets, which can be seen in our illustration being lowered into the cylinder housing. As already mentioned, the system of making up the cylinder assembly sets assists in the pressure testing of the cylinder housing water jacket. On the underside of the circular clamping plate on the top of the liner are two rubber washers, which blank off the water outlet holes in the cylinder housing, and each cylinder set after fitting into the housing is held down by two swivelling claw clamps attached to the circular plate. With the water outlet holes blanked off and the inlets fitted with hose connections the water jacket is hydraulically tested to 60 lb per square inch. Upon the completion of this test the cylinder housing moves along the production line to the next station, where the clamps, plates and spacer blocks are removed and returned to the sub-assembly fixture.

Cylinder Block Assembly

European Machine Tool Exhibition

THE Machine Tool Trades Association has addressed a note with regard to exhibitions to intending exhibitors at the fourth European Machine Tool Exhibition. The note draws attention to a method of procedure of the European Committee for the Co-operation of the Machine Tool Industries. This procedure enables the committee to decline to allot space at one of its own exhibitions to a manufacturer who has participated in the year of a European Machine Tool Exhibition in another European exhibition of international character.

This procedure, it is pointed out, is the outcome of one of the aims of the committee—to reduce the number of exhibitions held in Europe at which it will be necessary for machine tool manufacturers to be represented. The fourth European Machine Tool Exhibition will be held in Milan in September, 1954, and the next one will be held in Paris in 1957. Thereafter the exhibitions will be held biennially.

Metallurgical Topics

Cemented Tungsten Carbide as a Bearing Metal

CONSIDERABLE interest exists on the application of cemented tungsten carbide to precision-grinding spindle bearings, in which the life of other materials is short on account of wear with the consequent necessity for frequent replacements. To test the feasibility of using cemented tungsten carbide as a bearing material a research was organised by makers of tungsten carbide cutting tools, precision-finished parts and lubri-

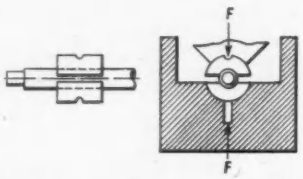


Fig. 1—Arrangement of Bearing for Test

cating oils, and the work was carried out by Professor J. S. Kozacka, of the University of Illinois, who has presented his first progress report.* After preliminary tests, bearings and journals, both of cemented carbide, were made up as shown in Fig. 1. The carbide used contained 94 per cent of tungsten carbide and 6 per cent of cobalt. Bearings and journals were carefully finished by grinding and diamond powder lapping. They were accurately measured, the diameter of the journal being of the order of 0·312in and that of the bearing from 0·1 to 1·0 ten-thousandth of an inch greater. The test bearing halves and the journal were placed in a reservoir (as indicated in Fig. 1) and this was filled with 22 c.c. of the desired lubricant. Thus, during the test the bearing and the journal were submerged completely in lubricant. The load was applied through a hydraulically operated machine. Frictional tests were run at a constant speed of 2750 r.p.m. on three bearings, A, B and C, with lubricants consisting of a straight mineral oil or of the same oil with 10 per cent of an extreme-pressure base, and with bearing pressures varying from 44·2 lb per square inch to 618 lb per square inch in multiples of 44·2. The bearings differed in degree of surface finish to the extent shown in the following table :

Surface Finish : Micro-inches

	Surface Finish Bearing	Micro-inches Journal
A	15–30	20–65
B	4–10	3–50
C	1½–2½	1– 3

The machine was allowed to run without load for fifteen minutes and was then loaded. Results of the friction tests, running at a constant speed

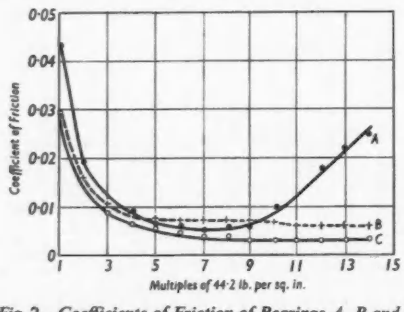


Fig. 2—Coefficients of Friction of Bearings A, B and C under Different Pressures, from 44·2 lb per Square Inch to 618 (i.e. 14×44·2) lb per Square Inch, with Mineral Oil Lubricant

of 2750 r.p.m. with mineral oil as lubricant, are shown in Fig. 2. The coefficient of friction decreases with increasing pressure. This was true for all the bearings, each with a different surface finish. At a pressure of about 300 lb per square inch, however, the coefficient of friction of bearing A started to increase with increase of bearing pressure, whilst those of B and C remained reasonably constant. Temperatures, initially 35 deg. Cent., rose to 64 deg. in bearing A, 46 deg. in bearing B and 43 deg. in bearing C. The early increase in coefficient of friction for bearing A when low-viscosity mineral oil was used as a lubricant was attributed to metal-to-metal contact between the irregularities of the journal and of the bearing surfaces. It was assumed that these asperities were cutting through the oil film, since visual examination of the bearings, immediately after each test, had shown a few bright rings on the surfaces of bearing and journal A, but none on bearings and journals B and C.

Friction tests were also made in which the same mineral oil with 10 per cent of extreme-pressure base added was used as the lubricant. Fig. 3 shows the curve of coefficient of friction of

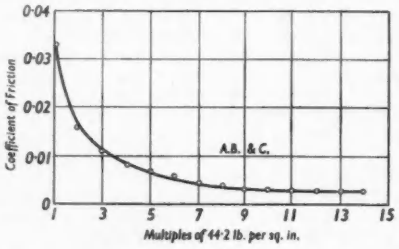


Fig. 3—Coefficient of Friction of Bearing A under Different Pressures from 44·2 lb to 618 lb per Square Inch, with Lubricant Containing 10 per Cent E.P. Base. (Bearings B and C gave Similar Curves)

bearing A as a function of bearing pressure. As nearly as can be shown on such a diagram, the curve also represents the coefficients of friction for bearings B and C, B showing slightly higher and C slightly lower figures at pressures of 530 lb per square inch and over. The coefficients of friction of A and B are lower than in Fig. 2, and there is no definite indication of an increased coefficient at the higher loads. The addition of an E.P. base is thus quite beneficial for a roughly finished bearing such as A.

Wear and surface finish changes were investigated in running tests on bearing C with the E.P. base-containing lubricant. The test was made at a constant speed of 2750 r.p.m. with pressures

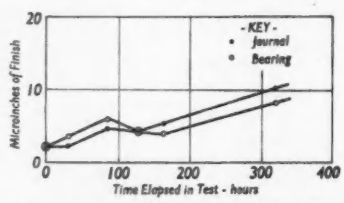


Fig. 4—Surface Finish in Micro-Inches Before and After Tests on Bearing C

of 884 lb per square inch for seventy-eight hours, followed by 350 lb per square inch for the next forty-two hours, and then 1765 lb per square inch for 200 hours. Measurements and weighing tests did not disclose any changes in size, but there was a deterioration in surface finish from the original 2–3 micro-inches to the final 9–11 micro-inches maximum. The average measurements are shown in Fig. 4, from which it would appear that the surface finish deteriorated under the bearing pressure of 884 lb per square inch, then improved slightly when the test was continued at 350 lb per square inch, though this may have been due to a slight error in reading. Further tests at 1765 lb per square inch indicated surface deterioration proportional to the running time.

The conclusion was reached that a cemented tungsten carbide bearing with the journal made of the same material could be run successfully under proper lubricating conditions at a considerable sustained bearing pressure. Journals and bearings with the finer surface finishes gave the better performance. Comparative tests with cemented carbide bearings and with a similar bearing made of drill rod, with kerosene as a lubricant, showed that the cemented carbide bearing was about five times more abrasion resistant than the drill rod bearing. Cemented tungsten carbide bearings cannot be run dry under conditions where a considerable bearing pressure exists. The beneficial effects of extreme-pressure lubricants were demonstrated best in the roughly finished bearing, but in order to prevent damage due to accidental overload their use is desirable even in highly finished bearings.

* "An Investigation of Cemented Tungsten Carbide as Bearing Metal," by J. S. Kozacka and others, *Trans. Am. Soc. Mech. Engrs.*, October, 1953, page 1203.

Notched Tensile Tests

AN investigation has been carried out by H. Schartzbart and W. F. Brown, jun.,* with the object of determining the effects of strain hardening characteristics and notch sharpness on the notched-bar tensile properties of various materials. Those investigated by the authors were annealed copper and 70 : 30 brass, hard-drawn copper, titanium, an annealed aluminium alloy containing about 4·4 per cent copper, 0·5 per cent manganese and 1·5 per cent magnesium and a temper-hardened complex alloy of cobalt-nickel-chromium with other additions. In conjunction with the results on these, consideration was given to previously published data on two aluminium alloys in the heat-treated condition, on a 0·25 per cent carbon steel and to a 0·4 per cent nickel-chromium steel, nickel about 1·2 per cent and chromium about 0·6 per cent, at two levels of tensile strength.

The specimens used by the authors for determination of the true stress-strain curves were of 0·177in diameter unnotched, or 0·25in diameter with a circumferential 60 deg. V-notch leaving a diameter of 0·177in at the bottom of the notch, i.e. with 50 per cent of the cross-sectional area removed by the notch. The radius of the notch was varied and its sharpness defined as a/r, where a is half the diameter of the bar at the bottom of the notch and r the radius of curvature of the notch. Thus, sharpness increased with increased diameter of specimen and with decreased root radius of the notch. The sharpness of a notch of root radius 0·01in in the test piece specified above would be 8·85.

The results are set out in a number of diagrams, the principal conclusions drawn being as follows : As the notch sharpness (as defined above) increases, the true stress-strain curve is raised and the ductility is decreased. These effects were most pronounced at low sharpnesses, decreasing in rate at higher sharpnesses. When the ductility becomes very low, the fracture stress begins to fall. Thus, the yield stress increases continuously with sharpness, rapidly at first, then less rapidly whilst the notched-tensile strength and fracture stress increase at low sharpnesses, reach a maximum and then decrease at high sharpnesses. The strain at which necking begins in the unnotched specimen influences the extent to which ductility is reduced by a sharp notch. The decrease in cross-sectional area after necking begins can occur by strain only, as is the case in unnotched or mildly notched specimens, or by cracking, as is the case in some sharply notched specimens. The necking strain associated with mild notches was found to decrease with increased notch sharpness for all the materials tested except hard-drawn copper, for which it remained approximately constant. In unnotched and mildly notched specimens fracture started at the centre of the bar and a cup and cone type of fracture was obtained. At higher notch sharpness, beginning between 2 and 4, fracture started on the surface at the base of the notch and was at right angles to the axis of the specimen.

The static tensile test on circumferentially notched specimens has been the subject of many investigations in recent years and the effects of

* *American Society for Metals*, 35th Annual Convention, October, 1953, Preprint No. 37.

many variables in material and heat-treatment, in form and size of the specimen (including depth and sharpness of the notch), and in temperature of test have been determined. It is well established that in many circumstances the ordinary tensile test does not reflect the behaviour of materials in service, especially under conditions which produce concentrations of stress. The authors express the opinion that in these circumstances a notched tensile test is a better criterion of service performance than the ordinary tensile test. They do not, however, make any further comment as to how the notched tensile results are to be interpreted if the test is used for acceptance purposes.

In considering the practical value of the test it must be borne in mind that a single notched tensile test will probably not give the desired information about the degree of susceptibility of a material to brittle fracture. There must at least be comparison of the tenacity or the reduction of area of the notched and the unnotched specimens, or of the static and dynamic ductility of the notched test piece, or of the results of tests made at different temperatures. There are, moreover, difficulties in the measurement of reduction of area in notched specimens, which may well rule out this measurement in routine testing. (The authors used a measuring microscope to measure the diameter of the broken halves at three positions at 120 deg. apart.)

Though the notched tensile test may be of value for investigation purposes, and conditions of flow and fracture of such specimens deserve further study, it may be questioned whether it will in practice give more information than an ordinary tensile test plus one or more notched-bar impact tests at suitable temperatures.

Oxidation Hardening

In a paper on the "Hardening of Metals," J. L. Metjering* states that if silver containing 1½ atomic per cent of magnesium is heated in air, oxygen diffuses into the alloy forming molecules of MgO, which, by their comparatively large dimensions, deform the silver lattice with consequent increase in hardness. The surface hardness, initially 40, rises to 170. Similar effects are produced in silver alloys with aluminium or beryllium. Some copper and nickel alloys are also susceptible to oxidation hardening. No oxide layer is formed on the silver, but copper alloys are quickly covered with a surface layer of cuprous oxide. If, however, air is then replaced by an inert atmosphere, the oxide already formed is sufficient to complete the internal oxidation of the metal. It is essential that the dissolved metal shall have a greater affinity for oxygen than the basis metal of the alloy. Aluminium, beryllium and titanium are thus effective in suitable amounts in copper. The surface hardness of copper containing 1½ atomic per cent of beryllium is raised from 40 to 165 by oxidation hardening, but if the added metal is present in too large an amount, a layer of oxide roughly parallel to the surface is formed and impedes internal oxidation. The surface hardness obtained by this method is fairly resistant to subsequent heat-treatment, but a tendency to intercrystalline brittleness, which may show itself, is an unfortunate factor which may militate against practical application. Oxidation hardening was found not to take place in iron alloys.

American Society for Metals

The papers presented at the thirty-fifth Annual Convention of the American Society for Metals, held on October 19 to 23, 1953, covered a great variety of interests. There were, of course, many papers on steel, and the metallurgy of the rarer metals occupied an important place in the programme ; but there was no specific mention of the more common non-ferrous alloys, though one paper dealt with the creep properties of some alloys of nickel with cobalt, iron, tungsten and titanium.

The Rarer Metals and Alloys

The intensive research now in progress on titanium is shown by the fact that there were no less than eight papers on titanium and its alloys. Titanium exhibits many attractive properties and it may be expected ultimately to find wide application in the constructional industries. Meanwhile, however, it has several characteristics that have led to difficulties in processing and fabrication and would therefore prove detrimental to its application. Among these is the tendency of the metal and its alloys to seize and gall under conditions of wear or during extrusion or wire-drawing. With the object of eliminating these tendencies, a study of surface hardening techniques applicable to titanium metal was made by J. L. Wyatt and N. J. Grant.(3)* They found that the best method of producing a hard, adherent case on materials predominantly titanium was by nitriding with ammonia. The conditions of treatment and the mechanism of the process are discussed. The high hardness of the case (often exceeding Knoop hardness number 1000, compared with the initial 200) was held to be due to solid solution hardening by nitrogen and hydrogen. The formation of a gold patina of TiN on the surface made no apparent contribution to the hardness of the case because of the thinness of the TiN layer. The properties of titanium alloys are dependent on composition, fabrication procedure and heat-treatment. The effect of hot rolling temperature, solution treatment and ageing on titanium-chromium alloys containing vanadium or manganese, or both with iron and molybdenum was determined by W. M. Parris, P. D. Frost and J. H. Jackson (4). The transformation kinetics and mechanical properties of titanium-aluminium-molybdenum and titanium-aluminium-chromium alloys were described by H. D. Kessler and M. Hansen (5) and (6). The response to heat-treatment was chiefly a function of the molybdenum or chromium content. An aluminium content of 4 per cent or more did not greatly improve the strength, but markedly reduced ductility at moderate temperatures. The strength of the alloys could be varied between wide limits (e.g. 45 to 90 tons per square inch) by varying the heat-treatment. With the chromium alloys the highest strengths with good impact values resulted from air cooling from the beta field, or from an isothermal quench and five minutes' ageing at 500 deg. Cent. Isothermal transformation and its effect on the mechanical properties of titanium-molybdenum alloys were studied by D. J. De Lazaro and W. Rostoker (8), who found that, in the case of the 7 and 11 per cent molybdenum alloys, isothermal transformation gave strength-ductility combinations and impact properties generally superior to those obtained by quenching and reheating. P. D. Frost and others (7) dealt with isothermal transformation characteristics of titanium-manganese alloys.

Accurate determinations of oxygen are of importance in view of the effect of this element on the properties of the rarer metals. A. D. Kirshenbaum, R. A. Mossman and A. V. Grosse (1) suggest an isotopic method for the determination of oxygen in titanium and zirconium, whilst the vacuum fusion analysis of molybdenum is described by M. W. Mallett and C. B. Griffith (2). The embrittling effect of hydrogen on zirconium was studied by C. M. Schwartz and M. W. Mallett (14) and an equilibrium diagram of zirconium-aluminium alloys was produced by D. J. McPherson and M. Hansen (13). In a paper on the control of the mechanical properties of molybdenum J. H. Bechtold (15) showed the importance of grain size on room temperature properties. An increase in the grain size from 1700 to 100 grains per square millimetre raised the ductile-to-brittle transition temperature by about 100 deg. Cent. The papers included a survey of vanadium binary systems by W. Rostoker and A. Yamamoto (29) and a study of the gamma loop in the iron-vanadium and iron-vanadium-titanium systems by W. R. Lucas and W. P. Fishel (30).

Iron and Steel

A large number of papers dealt with the heat-treatment and mechanical properties of iron and steel. J. Vajda and P. E. Busby (9) devised a method of reproducing the slack-quenched structures obtained in heavy forgings by end quenching a 7in by 7in round section and taking specimens at different distances from the quenched end. The transition temperature in the impact test was progressively increased by the presence of increasing amounts of slack-quenched structure. In a 0·4 per cent carbon steel, boron may seriously lower the impact value when the steel is slack-quenched, but the addition of rare earth metals had little or no effect on the mechanical properties. E. F. Bailey (11) found that impairment of properties by non-martensite decomposition products (i.e. by slack-quenching) was not serious with 10 per cent decomposition, but with 30 per cent the effect was injurious, especially if pearlite and ferrite were formed. The 3·3 per cent nickel steel was less affected than a 0·8 per cent chromium steel or a 1·7 per cent manganese steel, each with about 0·4 per cent carbon. As the temperature of decomposition increased the detrimental effect on mechanical properties became greater. Attention was drawn by J. T. Ransom (12) to the adverse effect of elongated non-metallic inclusions on fatigue strength, especially bending fatigue limit obtained with transverse specimens and torsion fatigue limit on specimens taken in any direction.

The effect of pearlite spacing on the transition temperature of carbon steels containing 0·01, 0·2, 0·4 and 0·8 per cent carbon was described by J. A. Rinebolt (18), who found that (apart from the 0·01 per cent carbon steel, in which no effect was observed), there was a decrease in transition temperature as the pearlite spacing became finer. The effect of chemical composition on susceptibility to temper brittleness was studied in high purity synthetic alloys by R. Hultgren and J. C. Chang (26). This paper, on the whole, shows results which might be expected, but its contents invite comparison with the recently published work of Professor Preece and Dr. Carter.† Studies of brittleness also included a paper by L. J. Klingler and others (27) on the embrittlement of alloy steels induced by tempering at 260 deg. to 320 deg. Cent. The embrittlement was supposed to arise from the initial formation of platelet cementite in the original austenite grain boundaries before a general precipitation took place, and methods for minimising the effect were suggested. The occurrence of "fish-scale" fractures in doubly hardened high-speed steel has given rise to two papers—by E. Kula and M. Cohen (33) and by A. H. Grobe, G. A. Roberts and D. S. Chambers (34)—in which it is held that refinement of the discontinuous grain coarsening, which is responsible for the fractures can be attained by annealing one or more times before the third hardening.

Four papers dealt with boron steels. The Fe-Fe_3B system is discussed by C. C. McBride, J. W. Spretnak and R. Speiser (22), who conclude that boron forms an interstitial solid solution in gamma iron, but a substitutional solid solution in alpha iron. In another paper J. W. Spretnak and R. Speiser (20) put forward a working hypothesis for the mechanism of the boron hardenability effect. A. E. Powers and R. G. Carlson (21) found that boron increased susceptibility to temper brittleness of a 1·6 per cent manganese steel, but felt that the positive effect of boron on susceptibility was not of sufficient magnitude to warrant condemnation of commercial boron steels. The effect of boron in raising hardenability is known to decrease with increasing carbon content, but case-hardening steels containing boron are used to take advantage of the effect of boron on the core. G. W. Powell, M. B. Bever and C. F. Floe (23) have studied the carbon nitriding of boron steels. They found that whereas the hardenability of a carbonitrided case on a plain carbon steel is greater than that of the same steel in the carburised condition, the hardenability of a carbonitrided case on a boron steel is lower than that of a carburised case. This they attributed to interference by nitrogen with the action of boron.

Other papers refer to the constitution of ferritic stainless steels, electron microscope studies of tempering, including the influence of silicon, and the flow and fracture of single crystals of ferrite. Of a more general character, covering a range of ferrous and non-ferrous materials, were papers on recrystallisation and grain growth, supercooling and dendritic freezing of alloys, and on the notch-bar tensile properties of various materials.

* *Philips Technical Review*, January, 1953, page 203.

* The figures following authors' names refer to the number of the American Society for Metals, 1953, Preprint.

† *Journal of the Iron and Steel Institute*, April, 1953, page 387.

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RAILWAY WAGES

At a late hour on Wednesday of last week, it was learned with considerable relief that the National Union of Railwaymen had rescinded its decision to begin a strike at midnight on Sunday last, and that negotiations on railway wages were to be reopened. This announcement came at the end of a day of discussions between the British Transport Commission and the National Union of Railwaymen, in which the two other railway unions—the Associated Society of Locomotive Engineers and Firemen and the Transport Salaried Staffs Association—also joined. On the two preceding days, the Minister of Labour, Sir Walter Monckton, had talked with all the parties concerned in the dispute, and it was through his good offices that the negotiations, broken off a fortnight ago, were resumed. The present railway wages dispute—which still remains to be settled—dates back to early August when the three unions presented a claim for a 15 per cent wage increase. It was based upon the cost of living and upon the desirability of bringing railway workers' pay into line with that in other industries. The claim was rejected by British Railways and by the Railway Staff National Council, which constitutes the second stage of the accepted negotiating machinery. In November, the claim was referred to the Railway Staff National Tribunal, the final court of appeal, which consists of an independent chairman and two other members nominated by the British Transport Commission and the unions respectively. At the beginning of this month, the Tribunal gave as its award an increase of 4s. a week, a decision which the British Transport Commission expressed its willingness to implement, but which was emphatically rejected by the three unions. A subsequent offer by the Transport Commission to examine the whole wage and salary structure, provided the Tribunal's award was accepted immediately, met with the approval of the two smaller unions, but was refused by the N.U.R. It was at this point that the N.U.R. announced its intention to take strike action. Happily, that action has been averted, although the business of effecting an amicable settlement is still before the British Transport Commission and the unions.

When the negotiations were resumed last week, the British Transport Commission reiterated its willingness to examine, with the unions, the whole of the railway wage and salary structure. The purposes of such an examination, it was stated, would be to correct anomalies and give added incentives in desirable cases, and to investigate all standard rates of pay. As, however, such a review will of necessity take a long time, the Transport Commission, after consultation with the Government, has given the unions an assurance that, within two months from the operative date of the Tribunal's award there will be a further improvement, on a percentage basis, of the standard rates of pay. Whilst, therefore, the unions have not succeeded in getting the full amount of their original claim, the portents are that they have succeeded in gaining a good deal more than the Tribunal, after consideration of all the facts, felt able to award. In this instance at any rate the findings of the Tribunal—which is, after all, an important part of the accepted machinery of negotiation—have been virtually set aside. Yet sympathy with the railwaymen's demands has not been lacking. Their unions started off with a claim that had rather more reality about it than some of the wage claims which have recently been advanced in other industries. The existing rates of pay for several grades of railwaymen do not compare very favourably with those ruling in other industries. Furthermore, the differentials between the wages of skilled railway operatives, such as footplate men and signalmen, and the unskilled grades undoubtedly stand in need of the overhaul which has now been promised by the Transport Commission. It is to be hoped that the concurrence of the unions with the proposal to undertake a "comprehensive review" of the wage structure means that they are anxious to adhere to the principle of maintaining reasonable differentials in the wage rates of the various grades of railwaymen. In most of the wage claims that have been advanced in the post-war years, the emphasis has been on an all-round increase, and all too little concern has been shown by the unions for the essential difference between skilled and unskilled work.

There is, however, one important aspect of the whole matter that needs be kept very much to the fore. It concerns the methods by which the British Transport Commission will meet the forthcoming additions to the railway wages bill. Increased freight charges can only lead to increased costs in the products of industry at a time when it is imperative that costs should mount no higher. But the British Transport Commission is required by statute to pay its way "taking one year with the next," and by the end of last year its accumulated deficit had reached £31,500,000, a large portion of which unfortunately had been incurred by British Railways. At present, it is not at all likely that the railways can make sufficient economies—and at the same time increase their efficiency—to meet the whole cost of their new wages bill. Yet, herein, we suggest, is the biggest task immediately before the Transport Commission and the unions. Last week, both the Commission and the unions agreed "to confer in order to evolve ways of increasing the efficiency of the railway organisation." Nearly three years ago, as part of the settlement of a wage dispute, the three railway unions acknowledged "the imperative need of the fullest co-operation with the (then) Railway Executive in the elimination of waste of manpower, in increasing efficiency and improving productivity within the railway industry." To that end, it will be recalled, a special joint committee representative of the Railway Executive and the unions was set up. The fruits of that committee's labours, however, have never become very evident in increased efficiency and greater productivity. Now another joint endeavour of the same kind has been agreed upon. This time, surely, industry and the country generally have cause for expecting much more satisfactory results.

FOG DISPERSAL

Some three years ago we drew attention in these pages to some important research work on the possibility of weather control which had been carried out during recent years in America and Australia. We gave it the heading "Man Made Rain," since that was evidently the chief immediate objective of the endeavour. It became clear, however, during these investigations that the "cloud-seeding" method employed, whether by making use of dry ice (solid carbon dioxide) or of silver iodide, might be used not only for the purpose of causing precipitation of rain or snow, but with the further object of dispersing certain forms of mist. The carrier to cloud level first employed for either substance was usually an aircraft of some sort—as in the control of locusts and other pests—but it was later discovered that the silver iodide method could equally, and usually much more economically, be applied by braziers located on the ground so as to release fumes to find their way into the clouds which it was worth while to attack. The water particles in such clouds would then, if at the right temperature (say, minus 20 deg. Cent. or thereabouts) and of suitable

size, quickly coagulate and fall as snow or rain. Ordinary fog or mist, at other temperatures, was less affected, but there seemed to be a fair prospect that further research work might find out how to solve this problem, too. It was apparent that if this could be done the gain in certain parts of the world would be substantial, for besides the control of rainfall distribution, so making it more equal in its location and so assisting farming operations, it might show also how to alter the path and type of hurricanes and in addition provide a possible means of control of mist and fog.

It will be asked whether there is good reason for believing this control is at all nearer attainment ? Light is thrown on that question in a recent issue of our contemporary *Research*, where a preliminary account is given of investigations initiated at King's College, London, which seem to carry this whole problem an appreciable stage further. The investigations show that although the temperature range in ground mist or fog is seldom right for ordinary cloud-seeding methods to be effective, the addition of a very small amount of some detergent substance may enable this difficulty to be surmounted ; if this conclusion is confirmed by the full-scale experiments now proposed, there may be offered us the happy prospect of having at our disposal a cheap and effective means of dispersing fogs, leading to improved meteorological visibility near the ground, at civil or military airports for example. Such a means of dealing with fogs and mists would indeed have an immense advantage over the slow and only partial alternative of inducing the mass of the population to adopt smokeless fuels for all heating or power-producing purposes, desirable though that objective must remain. Conditions favouring the continuance of widespread fog are temperature reversals at altitude ; instead of the air temperature steadily cooling off at the normal lapse rate as height increases, it may sometimes show a rise (possibly due to the occurence of a current of warmer air), and when it does so all the air below becomes stabilised, as though enclosed by a sort of meteorological " lid." Then any smoke coming from short chimneys (and of tall chimneys, too, if the fog belt is deep) is confined within a height of only a very few hundred feet, and " pea-soup " conditions can thus arise, to the great hindrance of normal ground traffic, as well as of important sporting events and national ceremonials of every variety, not to mention its gravely deleterious effect on human health (as shown during the great fog of December 1952, in London). It would indeed be a wonderful improvement if the seeding of fogs by a few aircraft (or by other means) by some harmless chemical could cause the condensation of the particles of fog or mist into drops large enough to fall right out of the unpleasant mixture now called " smog."

This important addition to rainfall control technique is put forward by Mr. N. Pilpel, a research scientist at King's College, London, and has been submitted to the Minister of Supply by Sir Eric Rideal, Chairman of the Scientific Advisory Council. That the quantity of material needed in such operations is claimed to be very small indeed may perhaps be attributed to occurrence of the kind of chemical chain reaction to which we have become familiarised in descriptions of recent atomic research. Mr. Pilpel is careful to point out that " aspects such as the nature of the surface-active agent, the quantities required, the best method of application, the effect of contaminants and meteorological conditions generally, the ratio of seeder to surface-active agent for maximum efficiency, &c., all require extensive study." So there is much yet to do before the fuller-scale aspects of the proposed method of fog dispersal can begin to interest engineers practically. But if this ambitious dream should ever become a reality one result may be to transform the work of the Meteorological Office from the relatively passive role of predicting what the weather will be if " nobody does anything about it," into the decidedly active one of seeing that the weather shall be " what it ought to be." No doubt the drawing up of a definite programme for the " coming weather " will have its difficulties : one foresees active Question-times in the House of Commons, hot arguments and even perhaps close divisions between Government and Opposition ! But whatever the complexities the results are likely to be a vast improvement on just leaving everything to chance, as by long custom, perforce, it has been hitherto, and no doubt it will be for engineers to produce and to control the operation of the necessary equipment.

Literature

The Steam Locomotive in America : Its Development in the Twentieth Century. By ALFRED W. BRUCE. New York : W. W. Norton and Co., Inc. 7·50 dollars. London : George Allen and Unwin, Ltd., 40, Museum Street, W.C.1. Price 45s.

THE author opens this massive work with these words : " The Great age of the steam locomotive is past. The development, over a period of more than 100 years, of the steam locomotive is now (1952) a closed chapter in the history of motive power and transportation." In the United States, to which the author has largely confined his book, these dramatic words are probably true, and estimates are put forward that nearly complete " dieselisation " may be realised by 1965. One need not discuss here the reasons for this phenomenal change ; but Mr. Bruce has appropriately chosen this moment for a review of steam locomotive development. Apart from the short introductory and historical sections, the main work is subdivided into chapters on General Development, Power Transmission, Development of Basic Elements, Development of Individual Types, Special Service Locomotives, Growth and Development. Much of Mr. Bruce's story is told in very general terms. From non-technical sources a good deal of information has come from America regarding the results achieved by the more recent developments, and it would have been interesting to have full technical data concerning, for example, the very long engine workings regularly operated on Western Lines, such as the Santa Fe ; details of the servicing necessary to make runs such as those from La Junta to Los Angeles, 1234 miles, in twenty-eight hours, and to return after a turn round time of only seven hours. That it was done, we know, and in the operation of very heavy trains ; but what was necessary in the way of maintenance and of intermediate and terminal servicing facilities ? What was necessary for the still longer run of 1788 miles from Kansas City to Los Angeles, on which engines were handled by twelve different crews in succession on the one through run ?

Of the finer points of engine performance, such as are studied closely in this country, Mr. Bruce tells us very little. It would have been very interesting to be able to compare the basic performance of a Santa Fe 6ft 8in 4–8–4, or a New York Central 4–6–4 with that of our own " Britannias," a Great Western " Castle " or a Gresley " Pacific." On the matter of power output Mr. Bruce includes a chart—partly theoretical and partly the result of actual tests—for " a large 4–8–4 type engine," on which an evaporation rate of 110,000 lb of steam per hour corresponds to a maximum output of 5000 d.h.p at 65 m.p.h., though the indicated horsepower reaches its maximum of 6600 at 85 m.p.h. The coal consumption is then 18,000 lb per hour, or 3·6 lb per drawbar horsepower hour. This appears to be well above the best British standards for steady test-house conditions, but in making comparison the rather general terms in which the data given in Mr. Bruce's book are drafted must be taken seriously into account. More than 150 pages are covered by the chapter describing the development of basic elements, and notes are included on the mechanical aspects of every conceivable detail. It is all extremely interesting, but it would have been still more so had reference been made to the behaviour of the recent locomotives in service.

Mr. Bruce has concentrated on the machine itself, with little or no background in terms of the daily work it was called upon to do and the service it rendered in passenger and freight haulage towards the life of the United States. But the book is large as it is. Perhaps one day the author may be tempted to produce a companion volume under some such title as " The American Steam Locomotive in Service." Then the curiosity of British readers may be rather more completely satisfied as to how the great machines described by Mr. Bruce performed, week in, week out, year in, year out. Then, too, they may be able to follow more clearly how they came to be superseded, overnight as it were, by the new diesel-electrics. In the meantime Mr. Bruce's book deserves to become a standard work, but a standard work on only half the whole subject.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCOMOTIVE VALVE GEARS

SIR,—In reference to my contribution on the above subject, published in THE ENGINEER of December 11th, I wish to make the following correction regarding the valve setting of the W.R. " Hall " class engine. The " lead " in full gear is negative and the dimension I gave in Table III should therefore be shown as —0·18 and not 0·18. I regret this error on my part.

E. C. POULTNEY

London, N.W.3, December 18th.

SHORTAGE OF NAVAL ENGINEER OFFICERS

SIR,—I have read your leading article on this subject in the issue No. 5107, dated December 11, 1953, and cannot let the sentence go by unchallenged, where, dealing with career prospects, it is stated " the intelligent hardworking lad . . . should have little difficulty in reaching the rank of a senior captain. . . ."

I am not able to quote accurate figures, but a conservative estimate is that at least sixty

Lieutenant Commanders (E) enter the promotion zone each year. There are about thirty promotions of Lieutenant Commander (E) to Commanders (E) and about ten promotions of Commander (E) to Captain (E) each year. So that 50 per cent Lieutenant Commanders (E) can expect to reach the rank of Commander (E) and only 17 per cent can expect to reach the rank of Captain (E).

Of course, these figures are very rough estimates, but I think that the actual figures are of the same order, in which case they indicate that something else besides intelligence and hard work are necessary for promotion to Captain (E), which is much harder to get than you imply.

J. R. PATTERSON, O.B.E., D.S.C.,
Commander (E), R.N. (Retired)

Sunderland, December 14th.

"The Chartered Mechanical Engineer"

IN this our Christmas issue we have the pleasure of welcoming a new publication. The Institution of Mechanical Engineers has just circulated to its members the first issue of *The Chartered Mechanical Engineer*. This publication supersedes the previously existing Institution Journal. It will, however, carry on the main function of the Journal, which was to acquaint members with the various activities of the Institution. But it will contain additional material. Lectures and addresses, for example, will be printed and will in this way be made available to members in printed form much more rapidly than heretofore. It is anticipated that there will be also a "Foreword" each month discussing some aspect of the Institution's work. *The Chartered Mechanical Engineer* will be published monthly except in July and August. The Journal, which it replaces, used to contain very short summaries of papers to be read at meetings. In the new publication much longer and more satisfactory summaries, running to a length of about 1000 words, of all papers accepted for publication will be printed some four to eight weeks in advance of the meetings at which they are to be presented. The whole presentation is greatly improved and the material is much more readable. Each issue will be sent to all members of the Institution, now numbering some 40,000, and will be available to non-members at a charge of 3s. per copy, or an annual subscription of 27s. 6d.

Arrangements for publishing the Proceedings of the Institution are also to be altered. Publication of the existing Proceedings (A) and (B) and Automobile Division Proceedings is to cease in due course, but each paper will appear in full, with its discussion, as a separate issue, which will be available to members only upon demand. The result will be that members will be able to obtain copies of papers and their discussions in which they are specially interested more rapidly than at present. The Proceedings will, of course, be bound annually into volumes. Full preprints of papers to be presented will, as at present, be available to members whose interest has been aroused by summaries appearing in *The Chartered Mechanial Engineer*.

The first issue of *The Chartered Mechanical Engineer* contains a particularly interesting announcement. The Institution is to hold its Summer Meeting next year in Holland during the week commencing June 14, 1954.

HANDBOOK ON DIE CASTINGS.—A handbook, sponsored by the Advisory Committee (Die Casting), Ministry of Supply, has been compiled on the subject of die castings by Mr. F. D. Penny, of the Ministry's Armament Design Establishment, for the use of Service designers and inspectors. This book is intended primarily to assist designers to appreciate the advantages and limitations of die casting processes, assess the suitability of a particular component for production as a pressure or gravity casting, choose the best materials available, and to give guidance in designing the component in order that full advantage may be taken of the potentialities of the process and the materials chosen, It will also eb of value to those concerned with the production and inspection of die castings, both for the Services and general usage. The handbook is fully illustrated with photographs and line drawings and also contains tables giving data on compositions, physical and mechanical properties of die casting alloys, on limiting sizes and recommended tolerances. Copies of the book can be obtained from Her Majesty's Stationery Office at 6s.

"Sherpa" Tailless Aircraft

The small-scale tailless research aircraft described below has been constructed as a private venture by Short Brothers and Harland, Ltd., to investigate the properties of an aero-isoclinic swept wing, so called because of its property of maintaining approximately a constant angle of incidence spanwise when flexed. It is used in conjunction with all moving wing-tip elevons and several advantages arising from structural and stability considerations are claimed for it.

A DEMONSTRATION was arranged recently at Belfast of the "Sherpa" tailless aircraft which has been built by Short Brothers and Harland to investigate the properties of an aero-isoclinic wing and its use in conjunction with all moving wing-tip control surfaces.

This development aims to resolve some of the aero-elastic problems which are encountered with swept-back wing and tailless aircraft, and mention was made of it by the company's chief designer, Mr. Keith-Lucas in a recent paper.* These plan forms inherit in a more severe degree the structural deformation leading to aileron reversal. It is well known that in a straight-wing aircraft the effect of lowering the aileron on the outboard wing, thereby increasing its lift, causes a torsional displacement of the wing, such that the incidence of the wing tip is reduced. The loss of lift due to this distortion progressively decreases the effectiveness of aileron control as forward speed increases and can eventually lead to the complete reversal of the control effect. However, a straight wing has the property when flexed under aerodynamic loads of retaining along the span a constant angle of incidence, an advantage which is not shared by a swept-back wing. With this configuration a load applied, say, on the flexural axis at the wing tip will cause a progressive reduction of incidence towards the tip, which, though, in this case, cannot lead to aileron reversal greatly reduces the effectiveness of the aileron. Furthermore, in a manœuvre such as that of pulling out of a dive, this washout due to flexure results in a loss of lift aft of the centre of gravity of the machine, causing a loss of longitudinal stability, clearly depending upon the degree of sweep back and aspect ratio adopted. It is because of these effects that stiffness rather than strength has become the design criteria in swept-back wings and is thus an adverse influence on the structure weight of the machine.

If the load previously placed on the flexural axis is now moved well forward at the tip, a twist can be induced which counterbalances the warping due to pure flexure. The object of the aero-isoclinic wing, at the expense of certain dynamical complications, is so to relate the strength and stiffness of the wing that the air loading producing the wing flexure also twists the wing as to restore everywhere along the span the incidence it would normally lose, thus maintaining a constant angle of incidence. This has been achieved in the "Sherpa" by placing the torsion box well back on the wing so that the air loads acting at the quarter chord line have the required moment arm about the torsion box. In this arrangement the freedom of the main spar to twist is illustrated by the spanwise slit in the leading edge ribs and skin, as shown in our illustration of some wing details.

Because of the relatively low torsional stiffness which is necessary with this design, the problem of aileron reversal again arises and the company has adopted rotating wing tip controls which serve both as aileron and elevator, and also reduce the structural problems in maintaining the iso-clinic characteristic. This form of control was originally used by G. T. R. Hill on his tailless "Pterodactyl" aircraft in 1925 ; he was similarly the first to advocate the aero-isoclinic wing itself.

A number of advantages are claimed for this system of wing-tip controls, which have an area approximately one-fifth of the total wing area. They obviate tip stall at low speeds, for, due to their functioning then as elevators at the wing tips, they are at considerably reduced incidence. The rolling moment associated with side slip in swept wing and tailless aircraft is also reduced due, it has been found, to the action of the relative direction of airflow upon the tip surface. Their main advantage is the fact that they eliminate the possibility of both aeleron and elevator reversal.

The characteristics of this wing, it is thought, will be best suited for those military aircraft needing high sweep back and large aspect ratio, which have both to be capable of long-range flights at high altitudes and speeds, and capable of combat manœuvre at low altitudes.

The "Sherpa" tailless research aircraft might be regarded as a utility aircraft built as quickly and as cheaply as was expedient to investigate solely the slow-speed characteristics of the wing and controls.

The wing is constructed mainly of spruce and plywood, with light alloy in strategic positions, and is built as a unit attached to the fuselage at three points.

The main spar is situated on the 25 per cent chord line and is formed with upper and lower booms of laminated wooden construction. The shear webs are positioned at 35 and 60 per cent chord, and are of plywood construction, the 60 per cent web being of ply with a thick centre lamination. Metal angle pieces are "reduxed" and glued to the webs for the attachment of the skin sheeting.

With the exception of two ribs the main inter-spar ribs are of metal and wood, light alloy between the 25 per cent booms and the 35 per cent shear web, and plywood and spruce between the 35 and 60 per cent shear webs. Two ribs are of all-metal construction and carry the elevon control bearings. Intermediate ribs are fitted between the 35 and 60 per cent shear webs. Further ribs formed by spruce battens are fitted between main and intermediate ribs ; these are glued to skin sheeting and shear webs.

The leading edge ribs are all of light alloy, with the main ribs split forward of the lower main spar boom. The upper part of the rib is secured rigidly to the spar boom, the lower part being free to move. Intermediate nose ribs of channel section, fitted between the main ribs, are not attached to the main spar booms, but are glued to the leading edge sheeting and connected at the rear ends to a channel section member fitted between the main ribs.

In the centre section two robust metal ribs, with channel section members riveted to their upper and lower edges, are arranged in a "V" joined at the aft end and spaced at the forward end by heavy gauge transverse diaphragms. These ribs carry the wing attachment fittings, one forward at the 35 per cent position on each rib and one at the point where the two ribs join. The wing main spar booms are bolted to the metal centre section ribs and diaphragms through steel biscuit plates, and angle plates are used to secure the shear webs.

The lower surface of the wing inboard is completely sheeted with plywood except where the flaps are fitted. Ply with a thick centre lamination is used between the 35 and 60 per cent shear webs, thus completing the wing torsion box. The upper surface is covered with plywood back to the 60 per cent shear web, thence fabric to the trailing edge. The nose sheeting of plywood is fastened to the upper spar boom at 25 per cent chord and at the lower edge to the free flange of the nose ribs.

The elevons are of spruce and plywood, constructed around a built-up metal spar of octagonal section. The spar is positioned at 23 per cent of the elevon chord ; the main ribs which extend from nose to trailing edge are secured to the spar. An anti-balance tab is inset at the inboard end of the trailing edge of each elevon.

The elevon spar is made in two halves jointed at the break between elevon and wing, and the inboard portion of the spar is fitted between the two all-metal ribs, being secured to them through self-aligning bearings. The connection of elevon

* "The Shape of Wings to Come." British Association, Belfast, 1952.

to wing is made through machined fittings which are built into the mating ends of the spar. A bolt with conical bushes and a split sleeve is used at the joint, the detail being shown in the drawing.

The flaps, which are hinged to outrigger brackets on the underside of the wing, are operated by a pneumatic ram mounted on a transverse box structure located just forward of the engine front firewall. Levers fitted one at each end of the box structure carry chain sprockets and are coupled by roller chain and special link bars, the joints between chains and links being designed for non-reversibility.

The lever on the port side of the box structure is a bell crank, one side of which is connected to the piston-rod of the ram. Each flap is coupled to its respective lever on the box structure by a push rod.

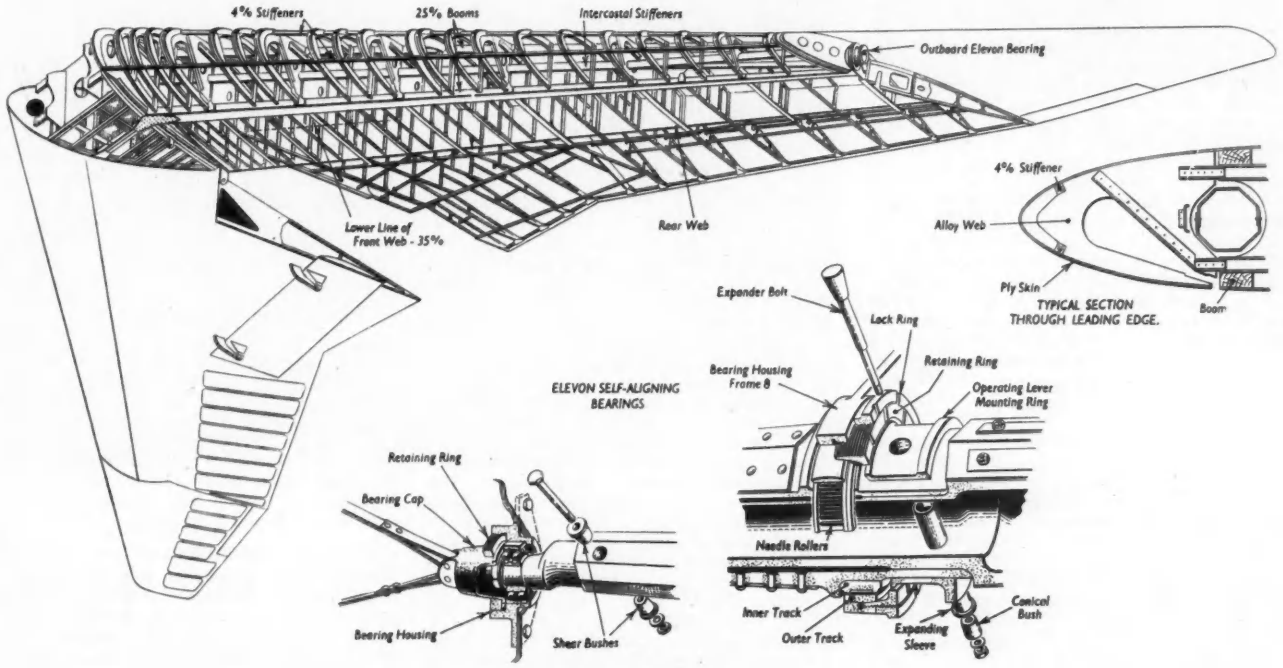
Elevons.—The elevons are operated from a normal spade-grip control column which is pivoted, a short distance from its lower extremity, to a fore-and-aft torque tube below the pilot's seat. Below and parallel to the torque tube is a tubular drag link attached at its forward end to the lower extremity of the column ; the aft end of the drag link is connected to a yoke fitting which hinges to the aft end of the torque tube above. With fore-and-aft movement of the column the drag link gives direct up-and-down movement to the elevons while the torque tube provides the necessary differential movement. Each arm of the yoke fitting is coupled by push rod to a bell crank lever in the wing root.

In the wing leading edge a series of universally jointed push rods are carried in self-aligning bearings and are attached through a special adjustable fork fitting to the bell crank lever at the wing root. The outboard ends of the push rods attach to an idler lever located inboard of the metal ribs. The other end of the idler lever connects to a tubular drag link, where it connects to the apex of a tubular " V " lever ; the arms of this lever extend forward to pivot on each end of a skew lever secured on a torque tube.

Adjustable stops are fitted, against which the apex of the " V " lever engages. A lever on the outboard end of the skew lever torque tube is connected by push rod to the lever on the elevon spar.

An anti-balance tab fitted on each elevon is operated by push rods connected to a sliding fitting anchorage on the wing structure. An electric motor and gearbox operated by the Eversheds " Powerotor " system is mounted in the wing and is coupled by push rod to the sliding anchorage of the tab push rods ; this arrangement has the effect of varying the fulcrum point and gives an additional travel of up to 8 deg. one way or the other to normal tab movement.

The aircraft has two Turbomeca " Palas " jet turbines mounted amidships, which together develop 700 lb static thrust at 34,000 r.p.m. They are started on petrol. The all-up weight of the " Sherpa " is 3125 lb.



Details of the Isoclinic Wing

Productivity—Are We on the Right Road ?*

By the Right Hon. LORD SEMPILL, A.F.C., F.R.Ae.S., M.I.Prod.E.

SINCE the dawn of machinery, concentration has been on the technique of making things, but very little attention until recently has been given to the technique of moving things. This has to be qualified since considerable success has been achieved in the science of transportation over long distances. The other aspect to which attention has been given is the development of motion study. It is clear, therefore, that success has been met in moving things over vast distances as well as for moving things at arm's reach. The gap between, that of " short-range transport," has been ignored, and it is only comparatively recently that attention has been given to this problem. It would be true to say that, whereas we lead in the invention, design and construction of handling equipment, we fail broadly to apply it to our own industry. It is very difficult to sell such equipment to other countries when the makers thereof can point to very little use in our domestic field.

The importance of " short-range transportation " may be illustrated by considering materials lying in a certain plant for 240 hours, of which time only ten hours was devoted to actual processing the material—a manufacturing efficiency of only 4 per cent ! It is not necessary to say more except to reflect on the expense of the investment, which in its turn demands excessive storage and handling facilities. A careful study in different fields shows that materials handling costs may vary from 30 to 90 per cent of the total production costs. It is not necessary to stress the importance of this aspect by further examples, except to quote from the same study that for every ton of finished product despatched some 50 tons of some kind of material entered the factory. The ultimate objective of " short-range transportation " is to reduce unit production costs, and this may be different from reducing materials handling costs.

As has been pointed out, we lag in the use of mechanical handling appliances, though we may claim to lead in the design thereof. One of the most interesting British inventions of the day—that of fluid drive—is being widely employed. This invention makes possible the transmission of power with a control of application superior to that of steam. Every phase of industry is touched by one of the most important developments of our day, that of electronics, without which it would be impossible to produce that high rate of productivity that our future compels. The foundations of what has become a great science originated in Britain, following the invention of the thermionic valve by Fleming and other fundamental work by Watson Watt.

There are two great differences between the industrial machine of the U.S.A. and our own : first, the attitude of mind of those on the job ; second, the enthusiastic adoption of mechanisation in America and therefore higher productivity. Long ago the Americans adopted the ideas of the late Henry Ford, that there is no limit in creating wealth with the result that there is a burning urge to adopt any and all new production techniques and mechanisms. The operatives do not worry about the company doing well, provided their pay packets reflect a practical appreciation of this fact. With us the majority take the view that the creation of wealth is very limited and that all should be governed by the lowest common denominator.

With us there is a great resistance to change, which varies in a marked way between the expanding and the non-expanding industries. The former, for example, electrical generation and manufacture, aircraft, automobiles and trucks, the latter railways, docks and coal mines. The former, seeing their increased output absorbed, are keen to adopt any improved techniques. The latter, seeing that the skill of production engineers is bound to reduce manpower, quite naturally resist the introduction of labour-saving devices, which, broadly speaking, are only permitted if they do not do their job—save labour. The process of mechanisation, which in many instances though not being actively avoided, is certainly not being vigorously adopted, and this to our peril. This process must be encouraged to the maximum. For a long time politicians have promised those in the non-expanding industries that they will not work themselves out a job and can carry on happily until they reach the retiring age. Such a state-

* Institution of Production Engineers, December 16, 1953. 1953 Viscount Nuffield Paper. Extract.

ment, of course, would imply that production engineers are remarkably inefficient or that the industries themselves refuse to adopt any of their labour-saving mechanisms. As the process of mechanical handling proceeds, men are bound in the non-expanding industries to work themselves out of a job. The matter must be dealt with in a sympathetic and straightforward way. This entails the provision of housing, near new centres of employment, to which hands no longer needed in, say, the docks would be welcomed—I repeat welcomed—as opposed to directed. Until this problem is settled in a human way, resistance to the adoption of new techniques and mechanisms will continue, with disastrous results to our industrial efficiency.

Cargo Handling

All forms of transport are vital to our living, and in particular is this so in regard to merchant shipping. In the years prior to the last war ships spent some 230 days of the year at sea, and 120 in port. To-day, with all the mechanical handling devices that are on the market—though not at our docks—the figures are 170 and 190. In other words, the time in port has increased by some 60 per cent. An appalling thought when one considers what could be. The ships could be operated far more efficiently and carry a greater quantity of ton miles of cargo per year. The more rapid turnround of ships and the carrying of more cargo per year is dependent on the raising of the standard of loading and unloading efficiency.

What can be done is well illustrated in Canada, where some 7000 tons of ore per hour are being loaded into ships by ten men. In an hour-and a half that gang can unload a 10,000-ton freight train, which means that each man is responsible for shifting 700 tons per hour. That amount per man-hour is a big figure as compared with our figure of about a ton per man-hour for general cargo, and shows to immense advantage the value of these new techniques.

Mechanisation in the Mines

The source of our national wealth and the product that made possible the Industrial Revolution of the last century was coal. Let us consider the present fifteen-year programme of modernisation and mechanisation which is well under way, and will eventually yield 30,000,000 tons more coal a year with 68,000 fewer miners. This programme will yield an increase of less than 2 per cent a year per person employed and will cost, over the fifteen years, £500 million. The result forecast is most disappointing. If the miners were to be paid all the increase in productivity that would result from the fifteen-year programme of modernisation and mechanisation, in terms of increased wages, they could expect about 4s. a week increase per year. This, of course, would allow nothing for reducing the price of coal.

To get some idea as to what is happening in the the efficient handling of coal, it is interesting to look back over the last few decades and consider what happens to the coal in a power station. Take a medium-sized power station, burning some 1600 tons of coal a day, which is about the output of a medium-sized pit. During the last thirty-five years productivity in the handling of coal in power stations has increased as much as eighteen times. As an indication of this, in 1915 it cost 6½d. to move 1 ton of coal from the wagon in the power station siding to the bunkers in the boiler-house. To-day, with wages approximately five times more than in 1915, it costs ¼d. This illustrates the remarkable difference in overall efficiency between the expanding and non-expanding industries. As has been pointed out before, in the former there is no question of labour redundancy and there exists keenness to discover, invent, install and use labour-saving equipment. In the non-expanding industries the same urge, except in isolated cases, does not exist, it being damped down by the fear of redundancy. This is perfectly natural, since human beings are not, despite the bureaucratic insistence that they should be, economic units. Unless the seriousness of the national situation is explained in simple language, the natural law of self-preservation will maintain, as it does, a high resistance factor.

How comes it that in the last thirty years the efficiency in handling the coal in a power station has increased by eighteen times, whereas in the ten years or so ahead there will be an increase of less than 2 per cent a year per person employed after the expenditure of £500 million?

A far better result could be shown, as may be illustrated by the following example. At a northern pit the number of miners has been reduced during the past few years from 1400 to 800, and the output of coal remains the same. The miners rendered redundant were absorbed into nearby pits. After the labour force had been reduced to 800, without any decrease in output, the working at the pit was reorganised on lines to fit new mechanical handling equipment and the necessary techniques. As a result the output has been substantially increased. Admittedly, this illustrates the exception, namely, that with the right human factor it is not impossible even in a non-expanding industry to equal in overall productive efficiency one that is expanding.

In the days of President Hoover, a Congressional Committee was established to report on the cost make up of the average article in the shops. This report showed that some 60 per cent or more of the cost was absorbed by a transport or handling charge. Investigations here produce no figures that would cause one to quarrel with those that apply in the United States. In these circumstances the speed, efficiency and economy of transport is vital.

Rail Transport

Let us look at another of the national enterprises, the railways, and particularly that aspect that deals with freight. Some 90 per cent of the goods trains dodder along at some 10 to 15 m.p.h. average, since the braking system is as chancy as that of the fifty-year-old cars that take part in the Emancipation Run to Brighton. This miserable speed is determined by the safe distance in which the locomotive, with the aid of one brake wagon with its hand-applied brake, can pull up a train weighing some 1500 to 1600 tons and consists of some fifty or more unbraked freight wagons. The driver has to be able to pull up within the same distance as a passenger train with its fifteen coaches, travelling at 80 m.p.h. ! The solution of this fantasy is not difficult or expensive, since by the fitting of continuous brakes to all goods wagons freight trains could run with existing locomotives at speeds almost the equivalent of passenger trains. There are a few which are called "fitted trains" that do so. By bridging this speed gap the number of trains running could be increased, there would be a far higher standard of punctuality, and the avoidance of those frequent bottlenecks at goods yards. Here is a way for the improvement without any great delay of the freight service, the lifeblood of industry.

The Building Industry

It is a strange thing that the Industrial Revolution, which transformed so many of our industries, left the building industry almost unchanged. This state of affairs is not unique, and is to be found in other countries. As might be expected, the first to adopt mechanisation for building were our friends in America. They have vigorously taken up a production engineering approach to these problems, and since we have so great a need for better housing, built with less man-hours, it is essential we should take stock of what can be and apply these new techniques and mechanisms.

The building and civil engineering industry employs some 1,500,000 people with a further 400,000 in the building materials and components industries. This is some 8 or 9 per cent of the working population, and is more than there are in agriculture and about equal to those in the engineering, shipbuilding and electrical groups of industries. The capital invested is large since building and construction work generally account for some 60 per cent of the total gross fixed investments. This compares with 50 per cent in the U.S.A. The figure for Sweden is about the same as our own. What is happening with these vast resources in action ? In 1950 the Girdwood Committee estimated that the man-hours needed to build a given kind of house in 1949 were 26 per cent above the 1938–39 level. This was an improvement on 1947, but it represented a 20 per cent drop in productivity compared with pre-war days. Productivity, broadly speaking, has risen since 1938. The cost of a house expressed as a fraction of the national income is nearly one-fifth more than it was in 1938. There is a very close relationship between productivity in this industry and the use of machinery. The average American worker uses some three and a half times more electrical power than his British counterpart, and this is one of the reasons for higher American productivity. In other words, each American worker has some sixty or more hands to command and each British worker some twenty.

Here is a tremendous field for mechanical handling. Take, for example, the building of two small semi-detached houses, and remember that much of the material is moved more than once and some 1200 tons is moved on the site and by hand. There is nothing so expensive as "cheap unskilled labour."

We are embarked on a new Elizabethan Age, but have not yet settled down to the different tasks that we must all perform if we are to do justice to the example of our predecessors some four centuries back. That we can do so I stand entirely convinced, and would say with modesty that if we make proper use of the inventions that spring from the genius that God gives to the few we can not only equal but try to surpass the record of that glorious age.

Our inventive and creative abilities are still with us, and in these fields we can more than hold our own. Over the centuries we have developed a way of life that most nations endeavour to follow. The road has been a hard one, and we have often tried things well in advance of others ; if they have proved unsatisfactory we have discarded them. Some three centuries back we experienced a totalitarian régime. Our forebears would not put up with the "Police State" technique with all its attendant horrors. Our future cannot be secured by any robot-like regimentation of machines, and we must fight against every attempt to turn us into numbers. It depends on the things of the spirit, and that spirit latent in mankind has to be awakened. It is only by this awakening that we can think not narrowly of ourselves and our imaginary rights, but of our duties to civilisation, immature as it may be, its maintenance and extension by future generations.

Attitude of Mind

In the opening part of this address it was emphasised beyond doubt that the key to the whole problem of greater productivity and general national well-being lies in our attitude of mind. It is vital that the leaders of our country together with the captains of industry, through the B.B.C. and on the floor of the shop, should explain in simple human terms that we can all understand, the plain fact that unless we have new thoughts on the methods of making the industrial machine work, by the unstinted use of mechanisation, the lowering of our standard of life is inevitable.

Books Received

Strength of Materials. By G. H. Ryder. London : Cleaver-Hume Press, Ltd., 42A, South Audley Street, W.1. Price 21s.

Workshop Costs and Costing. By P. S. Houghton. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 35s.

Mechanical Vibration. By G. W. van Santen. London : Cleaver-Hume Press, Ltd., 31, Wrights Lane, W.8. Price 35s.

The Chemical Industry : Past and Present. By T. I. Williams. Middlesex : Penguin Books, Ltd., Harmondsworth. Price 2s.

Technische Messungen. By A. Gramberg. Germany : Springer-Verlag, Reichpietschufer 20, Berlin, W.35. Price Dmk. 36.

Kinematische Getriebesynthese. By Rudolph Beyer. Germany : Springer-Verlag, Reichpietschufer 20, Berlin, W.35. Price Dmk. 36.

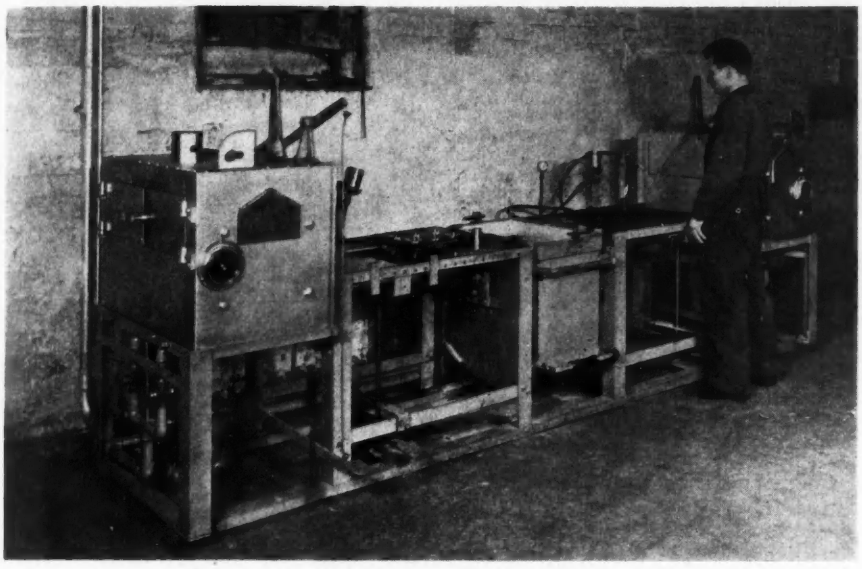
Ford Engines. By J. W. Sanderman. London : George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 10s. 6d.

Collected Papers. By S. P. Timoshenko. London : McGraw-Hill Publishing Company, Ltd., 95, Farringdon Street, E.C.4. Price 140s.

Uniforms and Industrial Clothing Catalogue. Produced by United Trade Press, Ltd., 9, Gough Square, Fleet Street, E.C.4. Price 10s.

Shell Moulding Machine

A VERY large number of small castings are called for in the manufacture of textile machines, and Fairbairn Lawson Combe Barbour, Ltd., of Leeds, decided some time ago to investigate the possibility of increasing production by introducing the shell moulding technique into its foundry. Following experiments with makeshift equipment a plant was developed which has not only given an appreciable increase in production, but also reduced the number of subsequent machining operations required by producing castings to closer tolerances than was hitherto possible. We recently had an opportunity to see the new machine in operation and some photographs of it are reproduced on this page.



Shell Moulding Machine

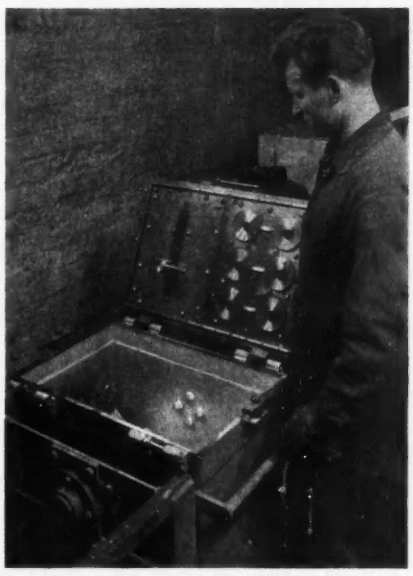
The machine consists essentially of a framework of steel angles and bars supporting a central trunnion-mounted dump box with a short length of guide way extending from each side and terminating in a gas-fired oven. In the plant illustrated the dump box is arranged for manual operation, but a more recent machine is fitted with a compressed air operated turning gear. The dump box has a capacity of 2 cwt and it takes patterns 24in by 16in, which have an effective area of 23in by 15in. Patterns with a height of up to 4in can be used. A pair of hinge pins and two locking clamps for the patterns are fitted to the upper edges of the box.

The upper members of the main frame, which form support and guide ways between the ovens and the dump box, are fitted with rollers along which the patterns can be rolled with the minimum amount of effort on the part of the operator. These guide ways extend right into and along the floors of the ovens, which have pedal-operated, counterbalanced sliding doors on their sides. Pedal-operated ejector plates are supported on the frames just outside the oven doors. These plates in their inoperative position are about 2in below the pattern support rails.

Brackets arranged at a convenient height at the rear of the frame and adjacent to the ejector plates carry a compressed air gun, for cleaning the patterns, and a spray gun for applying the liquid release agent on the patterns before they are invested. Each oven is fitted with a thermostat control and has an upper and lower chamber. The lower chamber is used for curing the moulds and the upper chamber for preheating the patterns. By having preheated patterns ready, loss of time in preliminary heating is avoided when changing over from one set to another.

In the sequence of operations the operator slides a prepared pattern along the guide rails until lugs on its side register on the dump box hinge pins. The pattern is then swung over on to the top of the box, as shown in one of our illustrations, and locked in position by clamps at the front and rear. The dump box is then turned upside down and held in this position for the predetermined investment period. At the end of this period the box is returned to its position of rest, the pattern unlocked and swung back on to the guide rails. The operator then depresses the pedal to open the oven door and slides the pattern along its tracks straight into the curing chamber. This operation can be seen in another of our illustrations.

By this time the mould in the oven at the other end of the machine is cured and the operator moves over and draws it on its pattern out of the chamber on to the section of track over the ejector plate. Depression of the ejector pedal brings the plate into contact with spring-loaded ejector pins built into the pattern and continuation of the movement lifts the mould off the pattern. When the mould has been released the compressed air gun is used to clean any fragments off the mould. The pattern is then sprayed with the releasing agent ready for investment and the next cycle of operations.



Pattern being Set on Dump Box

Placing Inverted Pattern in Oven

When the moulds are removed from the pattern the operator places them in racks at the rear and when a rack is full it is wheeled to an adjoining closing and pouring station. At this station the half moulds are clipped together and laid flat on a sand bed, and before the moulds are filled with metal weights are placed on the top shell.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

USE OF STRUCTURAL STEEL IN BUILDING

No. 449 (Addendum No. 1: P.D. 1736). Price 2s. 6d. This addendum deals with the use of tubular steel in building. The need for extending the scope of B.S. 449 to include the practice of using tubular steel members in building has been apparent for some time. Rather than await a full revision of B.S. 449, the above addendum has been issued. It sets out the modifications of, and additions to, clauses of B.S. 449 which can be applied to tubular steel structures. In due course, the addendum will be combined with the main volume.

PREFERRED NUMBERS

No. 2045 : 1953. Price 2s. 6d. The series of standardised numbers known internationally as "Preferred Numbers" are finding increasing application in the preparation of standards and in the devising of ranges of products and processes. The technical factors, advantages and practical applications of these numbers are discussed fully in B.S. 1638 : 1950, "Report on the Selection of Ranges of Types and Sizes (Preferred Numbers)," by J. E. Sears, C.B.E. The present standard, B.S. 2045 : 1953, has been prepared with the objects (*a*) of giving authoritative status to these numbers for application, where appropriate, in British practice, and (*b*) of providing readily accessible information on the numbers themselves for those who may have occasion to use them.

The B.S. 2045 lists the preferred numbers in the four principal series (R5, R10, R20 and R40), as well as the additional R80 series intended for special application. These numbers are the same as those agreed internationally by the International Organization for Standardization (Technical Committee I.S.O./T.C. 19, Preferred Numbers) in New York, June, 1952, and now published as I.S.O. Recommendation No. 7. For the series R5 to R40, the I.S.O. recommendation is in exact accord with the earlier agreement of the I.S.A., as given in *I.S.A. Bulletin* No. 11, 1935.

A special clause has been added explaining how supplementary series of any desired step ratio can be obtained directly from the principal series, provided the ratio corresponds with a preferred number. In this way the range of application of preferred number series is much extended.

Practical Application of the New British Standard System of Limits and Fits*

By G. J. PEARMAIN, B.Sc. (Eng.), A.M.I.Mech.E.†

This paper suggests methods by which the new British Standard system for limits and fits can be most efficiently applied in industry, and proposes a method of approach by which series of fits for various purposes can be selected from those shown in the British Standard. It refers particularly to Part II of the Standard which gives data on the application of various types of fit.

The choice of tolerances is discussed in relation to machine capabilities and fit requirements, and a series of fits for general engineering requirements is proposed. Methods of assisting the correct application of tolerances and fits in the design stage of a piece of equipment are suggested, and the use of methods of selective assembly is shown to be practicable, using standard limits. Assembly fits for ball and roller bearings are discussed, and it is suggested that a standard series of such assembly fits should be established.

THE object of this paper is to discuss the practical application of the new British Standard System for limits and fits, with reference to Part II of that Standard.

New Limit and Fit System

Before a detailed selection of fits is made from the system, certain problems must be resolved in order to determine the method of approach. They may be summarised as follows :—

(1) Should tolerances be unilateral or bilateral ?

(2) Should the fits be specified on the hole or on the shaft basis ?

(3) What approximate types of fit are required?

(4) What standard of accuracy is required or available ?

These points will now be considered in more detail.

(1) *and* (2) *Unilateral and Bilateral Tolerances and Hole Basis and Shaft Basis Fits.*—The new British Standard recommends the use of the hole basis, with unilateral tolerances, for specifying fits. This method has certain practical advantages, which are discussed more fully in Mr. Conway's paper.

(3) *Approximate Selection of Fits.*—Owing to the wide variety of requirements and conditions which obtain in the engineering industry, each organisation or industry group must undertake the final selection of series of fits for its own use. However, omitting for the moment any reference to fit symbols, it is possible to suggest several types of fit which will be of common interest, and it is thought that the following will satisfy the bulk of general engineering requirements :—

(1) A loose running or clearance fit, which may be used, in various grades of tolerance, for applications such as loose pulley bearings, for general purposes on less accurate machinery, or merely as a static clearance fit to ensure ease and certainty of assembly.

(2) A normal running fit, to cater for those applications where temperature conditions are normal, and bearing requirements such as load and speed are not excessive.

(3) A spigot or location fit for non-running applications where easy assembly must be guaranteed, together with a minimum of clearance.

(4) A transition fit for applications where a small amount of clearance or interference can be tolerated, giving fair ease of assembly, accurate location, and no danger of distortion on assembly.

(5) A force or drive fit which must have sufficient interference to secure items such as bearing bushes, but not sufficient interference to cause over-straining of the parts or to prevent dismantling from time to time.

(6) A heavy force or shrink fit suitable for permanent assemblies which, for example, must retain their grip under shock-load conditions.

(7) Fits suitable for the assembly of ball and roller bearings in housings and on shafts (considered later).

As a second choice series it may be desirable to add to the above list :—

(8) An easy running fit situated between fits (*a*) and (*b*) where more clearance is required than is given by fit (*b*) to cater, for example, for misalignment of widely spaced bearings.

(9) A close sliding fit, situated between fits (*b*) and (*c*), where accuracy of location with free movement is the prime consideration.

(10) One or two more transition fits. These will probably appear in any case owing to ball bearing requirements.

To avoid confusion arising from loose terminology it is not advisable to employ the descriptive terms for fits used above, but as this has been common practice in the past they are quoted here. It is far better to refer to a fit by the reference letter of its shaft member, e.g. an " f " shaft fit, or a " p " shaft fit. If it were adopted this procedure would eventually lead to a universal language of fits which would be understood in all countries using the I.S.A. system or systems derived from it.

(4) *Standard of Accuracy.*—The choice of suitable tolerances for a new design necessitates a compromise between several conflicting requirements. Every production engineer knows that close tolerances mean high production costs, and the first principle is, therefore, that, in order to permit rapid machining and give long tool life, tolerances should be as wide as possible consistent with satisfactory functioning of the assembly. The great difficulty is that it is seldom possible to define the absolute limits beyond which an assembly will not function satisfactorily, with the result that many designers err on the safe side and tend to specify tolerances which are unnecessarily close. On the other hand, due consideration must be given to the fact that wide tolerances tend to decrease wearing life, thus necessitating more frequent overhaul.

In the less frequent case, where the functional limits are known and strict interchangeability is desired, these functional limits must become the working limits beyond which no relaxations can be permitted, and the tolerances can be defined. In some cases, however, these limits would result in exceedingly close tolerances and, for economic reasons, means such as fitting on assembly or selective assembly must be adopted to permit some easing of production tolerances.

A further factor which must be considered, although strictly speaking it should not form a criterion for the choice of tolerances, is the quality of the available production machine tools. Designers should be aware of the capabilities of the plant at the disposal of the manufacturing departments, and should endeavour to ensure that the tolerances they allocate are realistic from this point of view. Obviously, this is not always possible, but careful design can sometimes eliminate the necessity for close tolerances.

It is difficult to give accurate information on the capabilities of various types of machine tool or various processes, but Fig. 1 is an attempt to give an approximate idea of what may be expected under average conditions. The processes shown are related to the tolerance grades of the new British Standard system, and it will be seen that the most commonly used ones are grades 6 to 11.

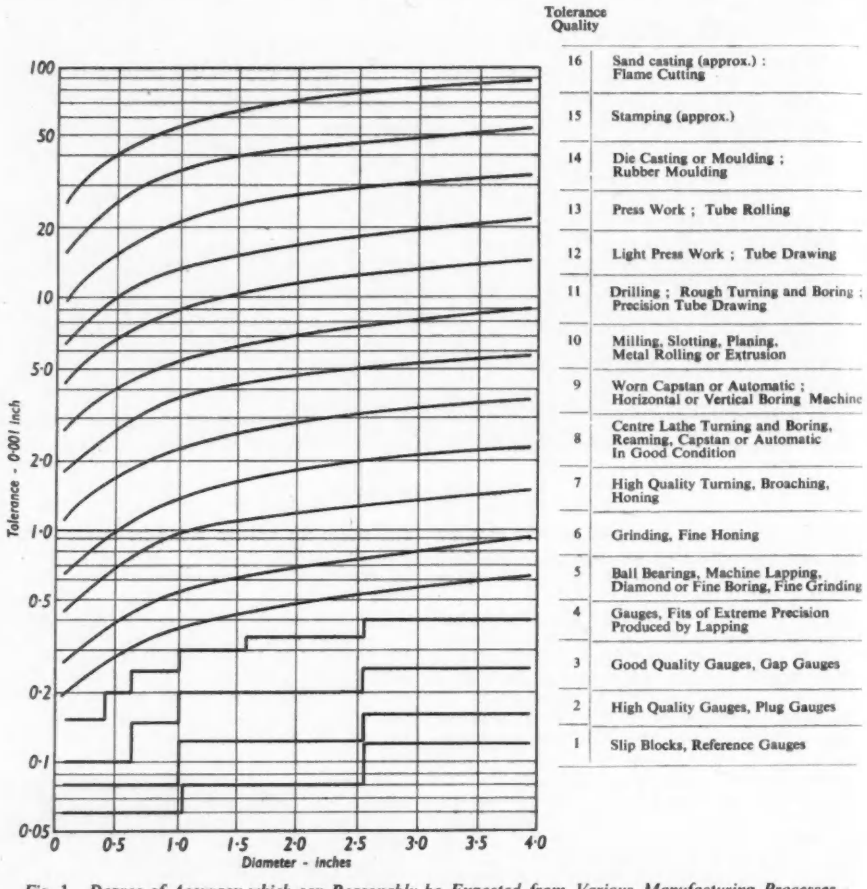


Fig. 1—Degree of Accuracy which can Reasonably be Expected from Various Manufacturing Processes under Average Conditions

Detailed Selection of Fits

Assuming that the problems outlined in the four preceding paragraphs have been satisfactorily resolved it then becomes possible to make a detailed selection of fits from the standard. When the recommended unilateral hole basis is used, the procedure is to select a series of fundamental deviations‡ for shafts to give the required fits in conjunction with a chosen series of tolerances. The allowance (maximum interference in the case of an interference fit) is a functional requirement which, in general, determines the nature of a fit. It can often be calculated, as, for example, in the case of a properly lubricated bearing, or it may be based

* Institution of Mechanical Engineers, December 18th. Abstract.

† Deputy Head of the Central Standardization Department of Philips Electrical Industries, Ltd.

‡ The fundamental deviation of a shaft is the upper limit in the case of an undersize shaft and the lower limit in the case of an oversize shaft. It corresponds to the allowance of a hole basis clearance fit.

solely on past experience. In either case the required allowance will be matched against those available in the system, and a suitable selection made. The tolerances are determined in the light of the factors mentioned in a previous paragraph. The series of fits illustrated in Fig. 2 is based on the approximate selection shown in a preceding paragraph, and utilises limits and tolerances from B.S. 1916.

An alternative approach to the selection of fits from the new standard, and one which will often be employed, is to seek those fits which approximate most closely to those already in

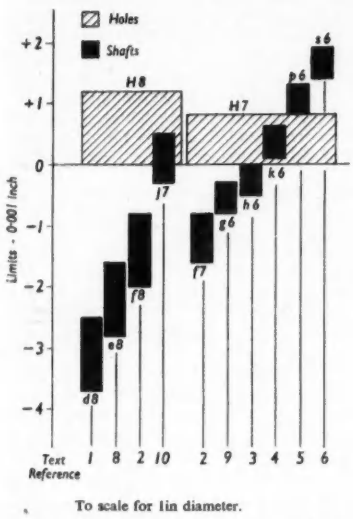


Fig. 2—Selection of Fits—Unilateral Hole Basis

use in a particular organisation. For this reason a table of equivalents in the B.S. 164 and Newall systems has been included in B.S. 1916. The relationships are approximate in each case, but the suggested equivalents will generally be acceptable, when it is borne in mind that, strictly speaking, in practice a limit of size cannot be represented by a sharply defined line, but should take the form of a rather indefinite zone.

Application of the Tolerance System in the Drawing Office

It has already been pointed out that the indiscriminate use of the new British Standard system will not of itself result in a very large measure of standardisation owing to its scope, and proposals have been made to limit the choice in a logical manner. It is also true to say that the indiscriminate use of even a limited selection of fits by an inexperienced person may also give rise to trouble. It is not sufficient to give each draughtsman a chart of tolerances and fits with permission to use them at his discretion, for their application is a skilled task, and should be regarded as such. The problem is rendered more difficult by the fact that conditions obtaining in different applications are seldom the same, owing to variations in one or more of the many relevant factors.

There are several ways in which this problem can be minimised. The first and obvious solution is to place the responsibility for the selection of all tolerances and fits in the hands of a senior engineer, or, if circumstances warrant it, to form a small section with these duties. These specialists would be able to assess rapidly the relative importance of the various conditions encountered in each application, and their accumulated experience would result in considerable savings by freedom from stoppages in production and changes in tolerances which otherwise might occur. Such a section might also include in its activities the overall checking of designs for conformity to standards, i.e. to ensure that the fullest use is made of those standards for raw materials, finishes, preferred sizes, &c., that the organisation recognises.

The tolerance specialist should logically be consulted when a piece of equipment or a machine is in the final design stage, before the detail drawings are prepared. His recommendations will be discussed with, and probably criticised by, the designers, with the desirable result that each application will be subjected to a searching scrutiny, thereby ensuring that the tolerances and fits finally chosen are the best from all points of view.

As a further aid to tolerance application, it will be of assistance if data sheets are drawn up to illustrate, in general terms, the uses of the various fits employed in a particular organisation. These data will provide a useful starting point when a particular application is considered and also a valuable means of instruction for the less expert.

If a company is producing a range of items of a similar type, it will also be advantageous to draw up design data sheets to illustrate the fits used throughout a typical unit. No dimensions need be specified, but only the necessary fit symbols, which will apply throughout a range of sizes. By this means similar units of varying size can be designed, and the application of the tolerances can safely be delegated to the detail draughtsman in the knowledge that the correct fits will be employed. Fig. 3 is a typical example, and shows the design data sheet for a hydraulic jack.

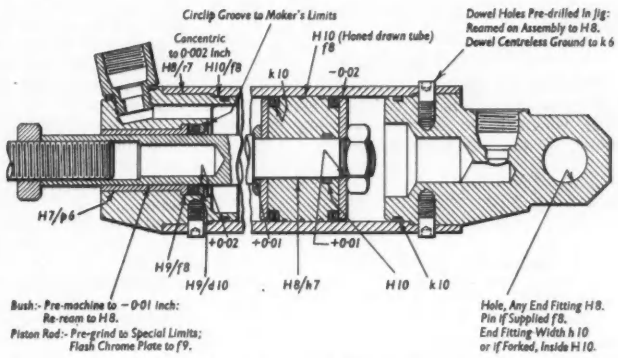

Circlip Groove to Maker's Limits
Concentric to 0·002 Inch H8/f7 H10/f8
H10 (Honed drawn tube) f8
Dowel Holes Pre-drilled in Jig: Reamed on Assembly to H8. Dowel Centreless Ground to k6
k10 −0·02
H7/p6
+0·02 +0·01 +0·01
H9/f8
H9/d10 H8/h7 H10 k10
Bush:- Pre-machine to −0·01 Inch: Re-ream to H8.
Piston Rod:- Pre-grind to Special Limits; Flash Chrome Plate to f9.
Hole, Any End Fitting H8. Pin if Supplied f8. End Fitting Width h10 or if Forked, Inside H10.

Fig. 3—Typical Data Sheet Giving Recommended Fits on Standardised Component Design

One of the fundamental difficulties of tolerance selection is that of appreciating the physical meaning of, say, a clearance of 0·001in. Drawing office personnel, through lack of practice with workshop problems, often fail to realise the significance of the tolerances and allowances they specify, either in terms of the resulting fit, or of machining possibilities, with the result that their judgment is unreliable. This difficulty can be overcome to some extent by providing each drawing office with a set of metal standards representing the various hole and clearance shaft limits used in the organisation. These standards can be manufactured to a convenient size, say, 1in diameter, and will form a valuable reference "library" to indicate the feel of the various fits. Such a scheme has been described by Loxham (*Machinist*, 1946) and uses a number of double-ended plugs, the ends of which are finished to the maximum and minimum limits of the shaft fits concerned. The pairs of rings which represent the basic hole limits are made with a length equal to one diameter.

The Effect of Probability

The application of statistical theory to engineering fits has been discussed in detail by many authors. Given certain operating conditions, the use of statistical methods will often permit the use of wider tolerances than would otherwise be thought possible to obtain a given type of fit. The most important prerequisite of such application, of course, is that the production method used shall be such as will result in a reasonably normal distribution of parts within the prescribed limits, and once this has been established a suitable sampling scheme can be developed for the inspection of the parts.

Further discussion of statistical methods is outside the scope of this paper. It should be emphasised, however, that they are by nature special procedures, and as such cannot generally be employed within the framework of a standard system of limits and fits. The new British Standard system, providing as it does a well-graded selection of allowances and tolerances, should, however, offer favourable opportunities for the introduction of statistical considerations into the selection of limits.

Selective Assembly

In spite of the increasing accuracy of modern production methods there are still instances requiring qualities of fit so high as to be unobtainable economically by the direct application of limits selected from a standard system, and in such cases some form of selective assembly has to be employed. Probably the most common example is the fit of balls and rollers in their bearing races, where the permissible variations in fit are of necessity so very small that they cannot be obtained directly. The application of selective assembly involves extra inspection and assembly costs, and also complicates the supply of interchangeable spare parts, although this point does not apply in the example mentioned.

The aim of selective assembly is to obtain precise fits with components manufactured to relatively less precise tolerances and, in the case of small production quantities, this is achieved by measuring every part and assembling selected pairs to give the required close fit. Where large production quantities are involved, it is more economical to divide the tolerance zones for each member into smaller zones, and to assemble those hole and shaft members which fall in corresponding restricted tolerance zones. The number and size of the zones can be calculated as follows (Fig. 4).

As an illustration a hole-basis clearance fit is considered, and T and t are the total tolerances

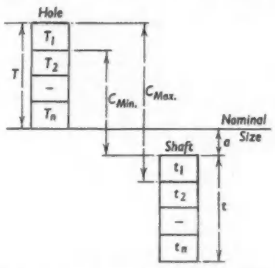


Fig. 4—Selective Assembly Employing Grading of Hole and Shaft Members

for the hole and the shaft, and a the fundamental deviation of the shaft. Each tolerance zone is divided into restricted zones T_1, T_2-T_n and t_1, t_2-t_n, and components from zones T_1 and t_1, &c., must give the required fit on assembly. This shows at once that the tolerances T and t must be equal, and that

$$T_1=T_2=T_n=t_1=t_2=t_n.$$

If C_{min} and C_{max} represent the known limits of clearance, which are determined by functional requirements, then

$$C_{min}=a+\left(\frac{n-1}{n}\right)T=a+T\left(1-\frac{1}{n}\right)$$

and

$$C_{max}=a+\left(\frac{n+1}{n}\right)T=a+T\left(1+\frac{1}{n}\right)$$

where n is the number of restricted zones. When T is given a value corresponding to an economical manufacturing tolerance it follows that the values for n and a can be determined. The theoretical value of a so obtained can be modified to correspond with a standard shaft deviation, and the final values of the limits of tolerance

calculated. It will often be found that a has a negative value, in other words, the upper shaft limit is greater than the nominal size. It is then necessary to choose from the tables a shaft having a lower limit equal to the calculated value, that is, equal to $|t-a|$. Such a shaft would be chosen from the series j to z.

A somewhat simpler method, when the shaft can be manufactured directly to the necessary degree of accuracy, is shown in Fig. 5. Here, as in the previous case, the hole tolerance is divided into restricted zones T_1, T_2-T_1, but having determined for a batch of parts the number of hole members in each group, corresponding numbers of shaft members are manufactured according to the zones of tolerance t_1, t_2-t_1. The limits for these shaft zones can be chosen from standard values in the system, e.g. shafts g, h, k, n, &c., with suitable tolerances.

Ball and Roller Bearing Fits

The selection of fits for the installation of ball and roller bearings is a problem of great importance which is constantly occurring in every branch of the engineering industry. The new

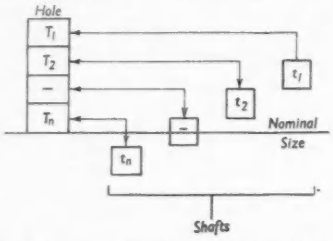


Fig. 5—Selective Assembly Employing Grading of Hole Member Only

B.S. 1916 makes no specific reference to this subject, and it will therefore be appropriate to give an explanation of the selection of fits for such bearings.

The limits and tolerances to which British bearings are manufactured vary somewhat according to the supplier, although the differences are often quite small. The tolerances specified on inch sizes of bearings are the result of early standardisation, and comprise bilateral bore tolerances and undersize limits for outside diameters. This scheme could now be improved, although there is little possibility of improvement owing to the multitude of bearings which are already in use and the replacement problems which would be incurred. In view of these differences, and of the unsatisfactory nature

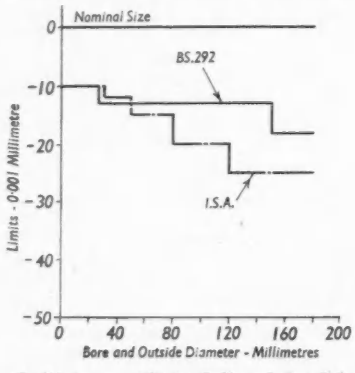


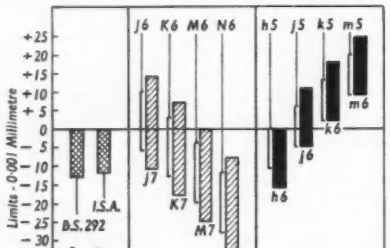
Fig. 6—Limits on Metric Ball and Parallel-roller Bearings

of the limits on inch bearings, it was not thought appropriate to include ball and roller bearing fits in Part II of B.S. 1916. Moreover, the manufacturers recommend suitable shaft and housing limits for use with their products under different conditions, and until national agreement can be reached designers will probably prefer to be guided by these recommendations, supported as they are by extensive research work.

With metric sizes of bearings the situation has been simplified by the 1950 revision of B.S. 292, wherein the tolerances on both the bores and the outside diameters are unilateral, and compare favourably with the I.S.A. tolerances specified by some manufacturers. Fig. 6 illustrates the two series, which are of similar form, and one is immediately led to ask why they cannot be brought into line with each other. This would be the ideal solution, but nevertheless, in the size range up to 80mm, which caters for the majority of requirements, the limits are already practically the same. It is therefore reasonable to expect that a common series of shaft and housing fits could be established, and an excellent opportunity is offered by the issue of B.S. 1916. This standard comprises in effect the I.S.A. system of limits and fits, from which some manufacturers already specify a series of shaft and housing fits for use with their products.

Fig. 7 illustrates, for a size range 30–50mm, the tolerances on bearings together with a selection of shaft and hole limits, extracted from B.S. 1916, which will be found suitable for assembly purposes under various conditions. This selection is quite extensive and will enable users to select fits suitable for their particular applications.

For reasons already mentioned the limits on inch bearings are less adaptable to modern requirements than those on metric bearings, and it is therefore encouraging to observe that there is a pronounced trend among designers away from inch sizes. This should be encouraged as much as possible, since on the one hand the designer will be enabled to use standard fits for shafts and housings, and on the other hand the manufacturer's problems will be eased. These organisations would no doubt welcome the



To scale for diameters of 30–50mm.

Fig. 7—Assembly Fits for Metric Ball and Parallel-roller Bearings

elimination of inch sizes, and lest this should be thought to be too revolutionary a step it should be noted that all American ball and parallel roller bearing sizes are, in fact, metric sizes converted into inch measure.

Preferred Sizes

The benefits which can be obtained by introducing a standard system of limits and fits can be greatly increased if the system is applied in conjunction with an agreed series of preferred sizes for the dimensions of fitting parts. A well-developed series serves to restrict the variety of sizes specified by designers, while in no way restricting their design function, and will lead to economies in material, tool and gauge stocks, storage space and stock records.

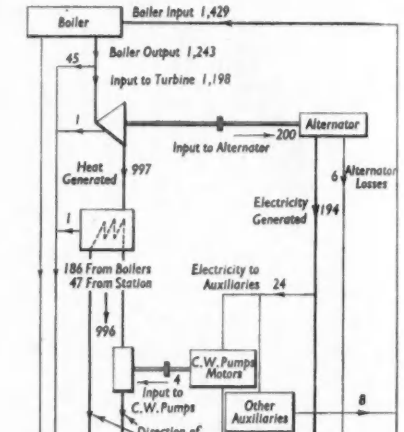
The technical features, advantages, and uses of preferred numbers in the general sense are discussed fully in B.S. 1638 : 1950 " Report on the Selection of Ranges of Types and Sizes (Preferred Numbers)," by J. E. Sears, C.B.E., and a new British Standard listing preferred numbers in the five series R5, R10, R20, R40 and R80 has been prepared. Successive terms in these series increase by 58, 26, 12, 6 and 3 per cent respectively.

Part II of B.S. 1916 contains series of fractional and decimal preferred sizes, and their use is strongly recommended in order to avoid the indiscriminate selection of dimensions. These series have been discussed between America, Britain and Canada, and will form the basis of an official A.B.C. agreement, the implementation of which will be recommended in all three countries.

Pimlico District Heating Undertaking

A paper with the above title was presented at the Institution of Civil Engineers on December 15th by B. Donkin, A. E. Margolis and C. G. Carrothers, and abstracts from it are reproduced below. As the Pimlico scheme has already been described in these columns (The Engineer, *July 27, 1951) our abstracts are limited to that section of the paper which describes the experience gained from two years' operation of the scheme.*

The Pimlico district heating scheme consists of two back-pressure turbo-generators with heat exchangers and circulating pumps at Battersea power station. The heating water is transmitted through heating mains in a tunnel to the substation at Churchill Gardens. Here a large capacity hot water accumulator is installed for storage of the heating water. The heating water is circulated from this point by an independent set of pumps to the flats in Churchill



Figures show energy in units of 0·25 therm per hour.
Arrows show direction of flow of energy, except where otherwise mentioned.

Fig. 1—Energy-Flow Diagram for Combined Heat-Electrical Generating Station under Conditions Similar to Pimlico Scheme

Gardens and Dolphin Square. The chief technical particulars of the combined heat-electric generating plant installed at Battersea power station are as follows :—

Two machines, each of maximum continuous output	1,350kW
Exhaust heat, per machine ...	227·5 therms per hour
Voltage of electric output	3,300 volts
Temperature of heat output ...	200 deg. Fah.
Initial steam pressure	600 lb per square inch gauge
Initial steam temperature	800 deg. Fah.
Back pressure of exhaust steam	2 lb per square inch gauge
Turbine speed	10,000 r.p.m.
Alternator speed	1,500 r.p.m.

The combined maximum heat output of the two sets is 455 therms per hour, which is sufficient to meet the peak demand of 750 therms per hour ; this is achieved by running the sets continuously on cold days, if necessary for twenty-four hours, and by making use of the hot water accumulator to store the excess heat output in the off-peak time and by night as required, and to make up the deficiency of heat output during the day. Reducing valves and desuperheaters are provided to supply low-pressure saturated steam to the calorifiers from the 600 lb per square inch steam mains in the unlikely event of an emergency. Space has been left at Battersea power station for the installation of a third set to meet future growth of heat demand.

The scheme has been in continuous operation for more than two years and systematic operating records are available for the period October, 1951, to September, 1953, inclusive. From these records it is possible to determine the

quantities of energy in circulation and to make an energy-flow diagram and a heat balance. The heat-energy meters on which the heat balance depends give consistent results and act as a fair check on each other, but their individual accuracies are not so reliable as to permit their differences being taken even as a rough indication of the losses, which are low in comparison with their errors.

The main point of interest about any combined heat-electric scheme is the ratio :—

$$R = \frac{\text{Electrical energy sent out}}{\text{Heat energy sent out}}$$

and the weight of evidence indicates that in the case of the back-pressure generators at Battersea, $R = 0{\cdot}17$.

Fig. 1 shows, in round figures, the estimated energy circulating in the form of heat, and mechanical and electrical energy in the main circuits of the Pimlico energy-flow diagram, which conforms with the following six assumptions :—

(1) The energy supplied for operation of the auxiliary plant is 2 per cent of the total energy sent out. The relative values of the energy quantities concerned are as follows :—

Heat energy sent out to district heating	100·0	
Electrical energy sent out	17·0	
Total energy sent out	117·0	
2 per cent of total to auxiliaries	2·4	
Estimated energy to auxiliaries as percentage of electrical energy sent out	14·1	per cent
Estimated energy to auxiliaries from operating records as percentage of energy sent out ...	12·1	per cent
Residue to circulating pumps at substation as percentage of electrical energy sent out ...	2·0	per cent

which is about twice the actual consumption of electrical energy at the Pimlico substation.

(2) Half the above 2 per cent to auxiliaries is returned, partly as mechanical energy to the circulating heating water and converted to heat by pipe friction, and partly as heat otherwise discarded. It is estimated that the actual return of energy would exceed half of that supplied, but the difference would have no significance so far as the overall heat balance is concerned. It might be noted that in a combined heat-electric generating station the auxiliary energy returned includes, in addition to the circulating pump energy, a proportion of the energy from all other pumps and fans in the water, air and gas circuits, and also the heat of auxiliary exhaust steam.

(3) 3 per cent of the mechanical energy input to the alternators is lost. This is estimated to be a reasonable average for all alternators, but errs on the low side for Pimlico.

(4) The heat loss from the surfaces of the turbines and heat exchangers is too small to consider separately and is included in the general heat loss of the station in the tables.

(5) 4 per cent of the heat output of the boilers is lost entirely in the station as radiation and convection from plant and pipework, blow down, soot blowing, drains, &c.

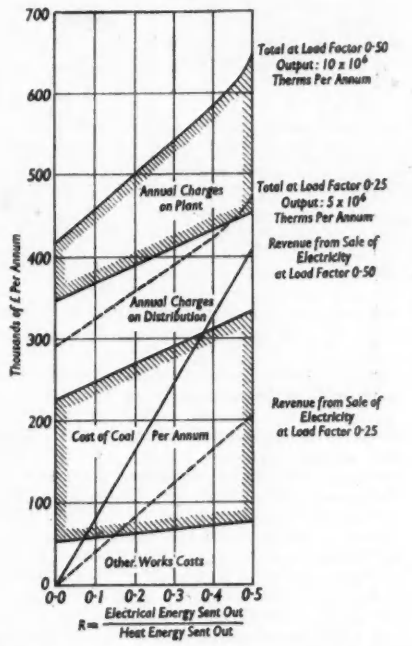
(6) The average thermal efficiency of the boilers is 87 per cent.

These assumptions are not likely to be seriously in error, either individually or in the aggregate.

Overall Economy.—The combined heat-electric generating plant at Battersea was installed as an addition to an existing condensing generating station. It is, therefore, impossible to state definitely what parts of the total capital charges and operating costs of the condensing and back-pressure stations should be allocated to each. For this reason no attempt is made in the paper to calculate the overall economy of the Pimlico district heating scheme as constructed, and this section of the paper is based on estimated prices for the combined generating plant as it could have been constructed, if designed as a self-contained unit. This can be done with sufficient accuracy, because each item of plant is of an established type on which adequate information is available. The distribution costs at Pimlico are known and the estimation of annual charges and operating costs of this part of the scheme can be made on a firm basis.

The estimates of annual charges and operating costs for the Pimlico scheme are readily applicable to the economy of other schemes operating under different conditions of steam and back pressure resulting in different values of the ratio R. This involves the consideration of generators of high thermal efficiencies which could only be achieved in practice with relatively large units of plant. The estimates for other values of R have, therefore, been based on an assumed annual "sent-out" heat of 10,000,000 therms compared with the actual 1·0–1·2 million therms per annum sent out at present from Battersea. The resulting estimated figures of annual cost have been plotted on Fig. 2 as a function of R. By this method of plotting the results, the variables appear as straight lines except for the capital charges on plant.

The costs are calculated for annual load factors of 0·5 and 0·25. The load factor of 0·5 is estimated to be attainable by schemes which include an accumulator and an exact


700
600
500
400
300
200
100
0
Thousands of £ Per Annum
Total at Load Factor 0·50 Output: 10 x 10⁶ Therms Per Annum
Total at Load Factor 0·25 Output: 5 x 10⁶ Therms Per Annum
Annual Charges on Plant
Revenue from Sale of Electricity at Load Factor 0·50
Annual Charges on Distribution
Revenue from Sale of Electricity at Load Factor 0·25
Cost of Coal Per Annum
Other Works Costs
0·0 0·1 0·2 0·3 0·4 0·5
R = Electrical Energy Sent Out / Heat Energy Sent Out

Heat sent out ... ... 10,000,000 therms per annum
Electricity sent out ... 146·5 million kWh per annum when $R = 0{\cdot}5$

Fig. 2—Hypothetical Scheme: Estimated Annual Costs of Operation

control of heat-dispatching as at Pimlico. The low value of load factor is included by way of contrast.

Fig. 2 also includes a graph of the estimated revenue from the sale of electricity. It is based on a two-part tariff of £6·3 per firm kilowatt sent out per annum, and 0·45 pence per kilowatt-hour sent out, based on coal costing 70s. per ton and having a calorific value of 11,000 B.Th.U. per lb. The firm output is taken as two-thirds of the installed plant capacity at 0·5 load factor and one-third at 0·25 load factor. The tariff given above accords with costs of electricity production at efficient modern power stations and has been used in a recent authoritative paper on this subject.

The resulting cost of heat to the consumer is obtained by subtracting the whole of the electricity sales revenue from the total cost of production and distribution and dividing by the total heat delivered to the consumers; that is to say, 10,000,000 therms per annum less 5 per cent losses, which gives the results shown in Table I.

Importance of High Load Factor and Ratio of Electricity to Heat.—It is clear from the above figures that it is economically sound to have a high load factor and a high ratio R of electricity to heat, provided that (*a*) the whole of the electricity sent out commands a substantially higher price than the same amount of energy sent out as heat; and (*b*) the incremental annual charges necessary to increase R do not exceed the resulting increase in revenue from the sale of electricity.

TABLE I

Ratio R	Cost per therm delivered to consumer	
	Load factor 0·5	Load factor 0·25
	d.	d.
0	10·31	15·2
0·1	9·22	14·6
0·17 (as for Pimlico)	8·46	14·4
0·2	8·17	14·2
0·3	7·16	13·8
0·4	6·30	13·6
0·5	5·80	14·3

For plant of the type installed at Battersea for the Pimlico district heating scheme, the factors which determine the ratio R of electricity to heat sent out are :—

(1) The mean effective temperature (in deg. Fah.) at which heat is absorbed by the water and steam in the boiler and superheater, denoted by T_1.

(2) The temperature (deg. Fah.) at which the exhaust steam is condensed at the turbine outlet, denoted by T_2.

(3) The turbine efficiency ratio, that is, the ratio of the heat converted to work in the turbine to the ideal available energy

$$\frac{T_1 - T_2}{(460 + T_1)} \ *$$

* $(460+T_1) = \frac{\text{(Heat of steam)} - \text{(heat of feed)}}{\text{(Entropy of steam)} - \text{(entropy of feed)}}$ at turbine stop-valve.

Table II shows the actual thermal efficiencies of the steam turbines for values of R ranging from 0 to 0·5, including $R = 0{\cdot}17$, the value obtaining on the Pimlico scheme. Table II also shows the initial steam conditions, feed and exhaust temperatures, and the turbine efficiency ratios necessary to attain the above efficiencies. It should be noted that the term "thermal efficiency" is applied here to the ratio between the turbine output of available energy and the turbine input heat-energy, without taking into account the turbine heat output which would bring the thermal efficiency of the turbine to little short of unity.

The achievement of a high ratio of electricity to heat involves the use of high initial steam pressure and temperature, and a high efficiency ratio involving a costly design of plant as shown by the increasing rate of rise of capital charges shown in Fig. 2. It is clear that for values of R exceeding 0·3 the demands on the turbine are becoming rather onerous, and for a ratio of electricity to heat of 0·4 or more, a different steam cycle from that used at Pimlico would be required.

TABLE II—*Combined Heat-Electric Generation*

Required steam conditions and efficiency ratio

Values of R	0·1	0·17*	0·27†	0·3	0·4	0·5
Input to alternator : thousands of therms ...	1,260	2,000	3,050	3,360	4,410	5,460
Input to turbine : thousands of therms	11,240	11,980	13,030	13,340	14,390	15,440
Efficiency of turbine	0·112	0·167	0·234	0·252	0·306	0·354
Initial steam pressure : lb per square inch abs.	260	610	610	900	1,400	2,100
Initial steam temperature, deg. Fah.	600	800	800	900	1,000	1,000
Feed temperature, deg. Fah.	200	200	320	360	400	440
Mean effective input temperature, deg. Fah. ...	392	465	495	551	610	665
Mean condensation temperature, deg. Fah. ...	180	216	180	180	180	180
Ideal efficiency	0·25	0·269	0·330	0·367	0·401	0·43
Efficiency ratio	0·45	0·62	0·71	0·69	0·76	0·82

* $R = 0{\cdot}17$ as for Pimlico. † $R = 0{\cdot}27$ Pimlico adjusted for lower back pressure and higher feed temperature.

Relative Economy of Pimlico Scheme.—It now remains to examine how the combined heat-electric generating plant installed at Battersea, to supply heat to the Pimlico District Heating Undertaking, stands in relation to the hypo-

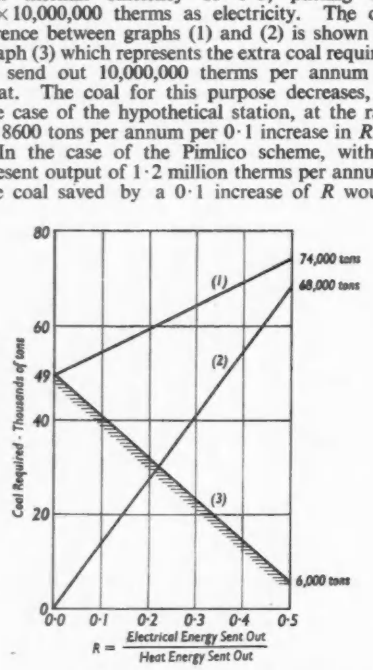
thetical figures. The operating conditions at Battersea are less favourable than those assumed for the other stations, because the temperature T_2 at which heat is discarded is 216 deg. Fah. compared with 180 deg. Fah. assumed for the hypothetical schemes, which would be equally suited to the heat requirements at Churchill Gardens. Also the efficiency ratio of the actual turbine is only about 0·63 compared with 0·75 which could readily be attained with the larger generating sets of the hypothetical scheme.

The high exhaust temperature of the back-pressure turbines at Battersea permits condensation at a pressure above atmospheric and a consequent simplification of plant at the expense of a serious reduction in the amount of electricity sent out per unit of heat ; the lowering of the efficiency ratio leads to a more serious reduction.

Adoption of the improved conditions of operation would increase the ratio R from 0·17 to 0·27, resulting in a saving in cost of heat delivered to the consumer of 1d. per therm and a saving of more than 1000 tons of coal per annum under present conditions of heat supply by the Pimlico District Heating Undertaking.

The coal consumption of a hypothetical combined heat-electric station, sending out 10,000,000 therms per annum as heat, and $R \times 10{,}000{,}000$ therms per annum as electricity, is shown for values of R from zero to 0·5 by graph (1) in Fig. 3. Graph (2) shows the coal consumption of a condensing station of sent-out thermal efficiency of 0·3, putting out $R \times 10{,}000{,}000$ therms as electricity. The difference between graphs (1) and (2) is shown by graph (3) which represents the extra coal required to send out 10,000,000 therms per annum as heat. The coal for this purpose decreases, in the case of the hypothetical station, at the rate of 8600 tons per annum per 0·1 increase in R.

In the case of the Pimlico scheme, with a present output of 1·2 million therms per annum, the coal saved by a 0·1 increase of R would



(1) Coal required for combined generation of 10,000,000 therms of heat energy and $R \times 10{,}000{,}000$ therms of electrical energy.
(2) Coal for separate generation of above electricity.
(3) Excess of (1) over (2), i.e. the extra coal for combined operation.

Fig. 3—Coal Consumption of a Hypothetical Scheme

just exceed the 1000 tons per annum referred to above.

The total saving in coal resulting from combined generation under the ultimate scheme (when the heat output is estimated at about 2,000,000 therms per annum) is estimated to exceed 3000 tons per annum. If account is taken of the elimination of open fires and other thermally inefficient methods of heating, the total saving in coal achieved by the Pimlico District Heating Undertaking will, it is estimated, exceed 10,000 tons per annum for the same quality of heat supplied.

Possible Future Developments

It has been shown that the introduction of the large capacity hot water accumulator has created a new economic basis for heat-electric generation and district heating. Both services can be run independently of each other. The annual load factor of a heat-electric station can be increased to that of a condensing station and the capital charges correspondingly reduced. The capital cost of a large capacity hot water accumulator, including insulation, amounts to about £3 to £5 per kilowatt of generating capacity, which is approximately equal to the cost of cooling towers for a condensing station.

An appreciable quantity of power, when not

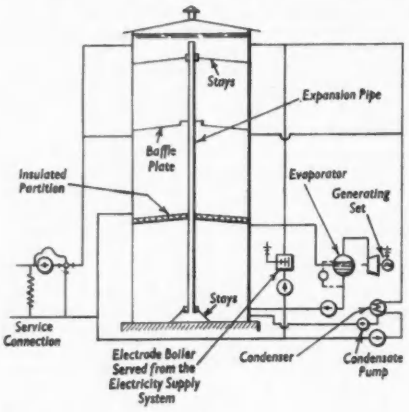


Fig. 4—Low- and High-Temperature Hot Water Accumulator

required for the general supply, can be made available for heating purposes by means of electric-thermal storage. This leads to the system of double-heat storage ; first, of exhaust heat at the generating station or substations for districts which can be served from a power station and, secondly, of electric-thermal storage for districts which are too far away from a power station, or which, for other reasons, cannot be conveniently served by exhaust heat.

The system of double-heat storage, as shown in Fig. 4, will facilitate the wide application of electricity to all kinds of heating, and so lead to a complete co-ordination of district heating, electric heating and electricity supply in general. The heat supply may be extended to isolated groups of buildings by means of hot water accumulators, heated by electrode boilers. In the case of industrial buildings, a proportion of the heat can be supplied with high-temperature hot water for process work which can be stored in the lower part of the hot water accumulator at a suitable pressure and temperature, which are balanced by the height of the low-temperature water column above the high-temperature hot water. The double-storage system increases the flexibility of district heating to suit various requirements of heat and of process work with moderate temperatures. Under favourable local conditions, it would even be possible to store high temperature hot water for the raising of steam which could be used for electricity generation, as by a battery of Ruths accumulators. The steam consumption of the high-temperature process is higher than that with Ruths accumulators, but the steam is produced by back-pressure generation and the secondary exhaust steam is fully utilised. The electricity output is, of course, limited by the permissible height of the hot water accumulator and by the consequent permissible temperature of the heating water in the lower compartment. The electricity output is reduced, but the total output, compared with Ruths accumulators, is increased. Owing to the favourable surface/volume ratio of large accumulators and the complete utilisation of the exhaust heat, the cost of peak power generation by this method can be considerably reduced.

By means of the large capacity hot water accumulator, it would be possible to vary the back pressure on the turbines and to store the heat in separate compartments of the accumulator at a lower or higher temperature potential, in accordance with operational conditions. The compartments would be separated, where necessary, by insulated partitions, and fitted with expansion pipes terminating at the highest water level of the upper compartment. The increase in the turbine efficiency would be the same as that of a turbine with one or several pressure stages, but this would be attained in the simplest way with one back pressure unit by variation of the load to suit best the required temperature conditions and to ensure the maximum electricity output.

Single storage of heat makes possible the transfer of heat from a lower to a higher temperature potential. By means of the double-storage system it would be possible to transfer a proportion of exhaust heat into electrical energy. This cycle of electricity generation in a heat-electric station, coupled with the storage of exhaust heat for heating purposes, thermal-electric storage for the heat supply of isolated areas or even of a remote village with generation of peak power at suitable points, would make possible the future co-ordination of electricity and heat supply for large urban areas.

Looking further ahead the time can be visualised when the scarcity and high price of coal in Britain will compel the adoption of heat-electric generation for all electric power stations located at centres of population and industry, where there would be an outlet for the waste heat. The economical siting of power stations will, in the future, depend on the nature of the load they supply. On the one hand, heat-electric stations will be in or near centres of population ; on the other hand, in order to make use of the vast quantities of very low grade fuel which has hitherto been largely a waste product of the collieries, some new power stations will have to be sited at the collieries ; since collieries are rarely centres of big populations, these stations would have to be mostly condensing stations, for there would be relatively little demand for low-grade heat in such areas.

The elimination from urban atmospheres of the distillation products of domestic coal fires, and the release from the daily task of delivering coal to, and removing ashes from, servantless households, may well be a potent factor in attracting families to live in cities within walking distance of their work. The elimination of the costly and time wasting daily travel, often under grossly overcrowded and unhygienic conditions, would give the city worker extra daily leisure, ranging from one to three hours, which could be used to the benefit alike of the individual and of the community.

The Churchill Gardens housing scheme is an example of housing people close to their work under conditions of comfort and cleanliness and at a price they can afford. Only when the whole of the Metropolis has been rebuilt on these lines and a smokeless zone established, will the population begin to recognise all the amenities attendant upon district heating.

The Pimlico District Heating Undertaking provides an adequate and reliable supply of heat to the consumers at a cost which compares favourably with other methods of giving the same service. There is no undue loss of heat in transmission, storage and distribution, and the economy of the Pimlico scheme is capable of improvement by the increase of the ratio of electricity to heat sent out from the combined heat-electric generating station. The use of a heat accumulator, as at Pimlico, is essential to the economy of a combined heat-electric system. The saving in coal by combined heat-electric generation is important to both economy and public hygiene.

Book of Reference

The Fire Protection Year Book, 1954. London : *Fire Protection Review*, 154, Fleet Street, E.C.4. Price 12s. 6d.—The fourteenth edition of this year book is divided into eight comprehensive sections, each dealing with a particular phase of fire fighting or fire protection. It gives a list of all the public and private fire brigades in this country and the Commonwealth and Empire ; Government departments and public authorities concerned with fire protection ; associations, institutions and societies interested in fire fighting and prevention ; the legal aspects of fire safety ; local authority civil defence officers and regional authorities in the United Kingdom ; fire engineering data, and a list of suppliers of fire safety equipment, together with a diary for 1954.

Industrial and Labour Notes

Railway Wages

At a late hour on Wednesday evening of last week, it was stated that, following talks with the Minister of Labour, representatives of the British Transport Commission had that day met representatives of the three railway unions concerning the resumption of wage negotiations. It was stated at the same time that, in view of the resumed negotiations, the National Union of Railwaymen had withdrawn the strike notices which were to have taken effect on Sunday last.

In a statement on the matter to the House of Commons, the Minister of Labour, Sir Walter Monckton, gave some details about the agreement which had been reached between the British Transport Commission and the three railway unions. He said that the Commission had confirmed its acceptance of the award of the Railway Staff National Tribunal for an increase (of 4s. a week) in rates of pay of salaried and conciliation staff. That position had been accepted by the trade unions in the light of other decisions which had been reached. In the first place, the Transport Commission was prepared to examine with the unions the whole of the railway wage and salary structure, the purposes of such an examination being to correct anomalies and give added incentives (including differentials) in desirable cases, and to investigate all standard rates of pay. At the same time, the British Transport Commission and the unions had agreed to confer in order to evolve ways of increasing the efficiency of the railway organisation, not only by such adjustment of wages and salaries as might result from the promised examination, but by all other appropriate means. Finally, recognising that the review of the wage structure would take some considerable time, the British Transport Commission, after consultation with the Government, had given an assurance that, irrespective of other results emerging from the examination, within two months from the operative date of the present award there would be a further improvement on a percentage basis of the existing standard rates of pay.

At the end of last week it was stated that talks between the Transport Commission and the unions about the "further increase on a percentage basis" would begin on Tuesday last.

T.U.C. and the Future

The general secretary of the Trades Union Congress, Sir Vincent Tewson, has issued a New Year message to the trade union movement. In the course of it he says that the recognition and the rights which the trade union movement has won and the benefits which it has secured by its constant effort have to be sustained. The improved standards which have been secured, Sir Vincent adds, depend upon the maintenance and improvement of the national economy.

Sir Vincent's message goes on to say that "we very largely depend upon industry for our livelihood as a nation and as individuals, and it is our responsibility collectively and individually to see that industry is efficiently performing its task. It is the job of trade unions to see that a fair share of the proceeds of efficient production reaches their members." It is no use, Sir Vincent comments, the Government "being content to wait on the chance turns of fortune to bring temporary trading benefits and to regard planning as something to be avoided like the plague."

Prices and Costs

Speaking at the annual meeting of Heenan and Froude, Ltd., on Thursday of last week, the chairman, Mr. C. L. Hill, said that the days were now well past when standard prices could be amended to take account of wage and material increases without affecting the flow of orders. A long period of stabilised costs of manufacture was needed if this country was to hold its own in world markets.

During the war, Mr. Hill continued, the engineering industry had of necessity to adopt special price variation clauses as part of the conditions of sale to provide for recovery of increased costs of wages and materials incurred between date of tender and date of delivery. That practice had become so standardised that it was difficult to break the circle unless one was prepared to gamble on wages and material prices remaining reasonably constant, and events of the post-war years did not encourage a return to sales at firm prices. It was inevitable, however, that as soon as the sellers' market ended buyers would begin to resist these price variation clauses. Unless, Mr. Hill added, some stability was given to costs, this problem would fast become an obstacle to export trade, which was already difficult on basis prices alone.

Commonwealth and Sterling Area Trade

The Board of Trade has issued the latest edition of the *Statistical Abstract for the Commonwealth and Sterling Area*. The first part of this publication has been expanded, since last year's edition, to include summary tables both for the sterling area and the Commonwealth generally for the years 1948 to 1952. The tables in this section relate primarily to imports and exports, but they also include some other data—such as production, consumption and prices of major commodities exported by the sterling area—as a general background to the trade figures. In the second part of the *Abstract* there are tables for individual countries showing the direction of trade of each country between 1949 and 1952.

A study of the tables reveals, among other things, that the general decline in the value of sterling area exports between 1951 and 1952, whilst common to all the major exporters among sterling Commonwealth countries, was not shared by many territories in Africa or the West Indies, the Rhodesias, Nigeria, Tanganyika, and British Guiana, nor by the Irish Republic or Burma. The information given enables the trade of each Commonwealth country with the various currency areas to be examined. It shows, for example, that South Africa's imports from the dollar area which in 1950 fell to less than half those in 1948, rose again in 1951 and 1952, and accounted for a quarter of her total imports.

The *Abstract* is obtainable from H.M. Stationery Office, price 15s.

Trading Conditions

In the course of his chairman's address at the annual general meeting of the Birmingham Small Arms Company, Ltd., which was held last Friday, Sir Bernard Docker commented on trading conditions generally, and expressed the view that the change from a sellers' to a buyers' market came at an opportune time. Sir Bernard said that it must have been obvious to everyone that the former position would not go on for ever, and it was timely, therefore, that the change should come while the sales force in the country still remembered how to sell, after being for a long period distributors of such goods as were available.

Sir Bernard went on to express his belief that this country did not need to worry about its ability to compete in the markets of the world. What manufacturers needed to worry about was that there should exist conditions under which they could, in fact, compete. Sir Bernard added that his "prescription" for those conditions included the removal at the earliest possible moment of all restrictive controls, including currency restrictions; economy in the administration of the functions of Government; reduction in taxation to provide an incentive both to industry and the individual, and the abolition of purchase tax.

Industry, Sir Bernard continued, still needed to sell its brains and its skill. Managements, he thought, must make an all-out effort to increase the scope of this country's sales by every method, and in that matter the practical sympathy of the Government was necessary. If managements succeeded, then full employment was possible, and for value of work given a good living was assured. To his mind, Sir Bernard said, too much attention was paid by too many to basic rates of pay. The criterion must be what a man took home on Friday night and could sufficient work be obtained to keep him employed.

National Coal Board Inquiry

In a debate in Parliament, towards the end of October, on the fuel and power industries, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, referred to some organisational changes which the National Coal Board had proposed. In particular, he mentioned the Board's intention to place upon colliery managers the maximum responsibility in the day-to-day management of their pits. He said also that the Board had issued instructions making it clear throughout its organisation that the area was regarded as the important unit of higher management.

At the same time, the Minister stated that the National Coal Board intended to carry out an examination of its whole organisation and, in particular, to make sure that that organisation was well adapted in the light of the instructions which had been given. At the end of last week, the Coal Board announced that the following had agreed to assist in the inquiry:—Mr. H. A. Benson, of Cooper Brothers and Co.; Dr. A. Fleck, chairman of Imperial Chemical Industries, Ltd.; Sir William Lawther, of the Trades Union Congress; Sir Herbert Merrett, chairman of Powell Duffryn, Ltd., and Sir Godfrey Mitchell, chairman of George Wimpey and Co., Ltd.

Imports of Sulphur and Iron Pyrites

The Ministry of Materials has announced that private trading in sulphur and iron pyrites is to be resumed on January 1st. Following that announcement, the Board of Trade has stated that it is now prepared to consider applications for licences to import sulphur from any source from January 1st, and that from the same date imports of iron pyrites will be permitted from any country, without the need to obtain an import licence. Applications for licences to import sulphur should be addressed to the Import Licensing Branch, Board of Trade, 43, Marsham Street, London, S.W.1.

Economic Planning Board

Before Parliament rose for the Christmas recess, the Chancellor of the Exchequer was questioned about the present functions of the Economic Planning Board, how often it meets, and whether any of its decisions may now be made public. He was also asked about the present composition of the Board.

In a written reply, the Chancellor stated that the functions of the Economic Planning Board were unchanged; they were "to advise Her Majesty's Government on the best use of our economic resources." The Board, which met frequently, was composed of experienced representatives of both sides of industry and senior Government officials, with Sir Bernard Gilbert as chairman.

Services to Exporters

For some time, the Board of Trade has been considering whether the services which it offers to exporters are sufficiently well known, and the Select Committee on Estimates has recently recommended that steps should be taken to publicise those services. It has been decided that this can best be done by a personal approach to manufacturers by the Minister primarily concerned with exports. Recently, therefore, Mr. D. Heathcoat Amory, Minister of State at the Board of Trade, has sent a letter to about 50,000 individual manufacturers and trade associations. The letter is accompanied by a leaflet summarising the Government's export services and a reply card on which manufacturers are asked to indicate their interest.

Notes and Memoranda

Rail and Road

CYCLE AND MOTOR CYCLE SHOW.—The council of the British Cycle and Motor Cycle Manufacturers' Union has agreed to hold a Cycle and Motor Cycle Show next year from November 13th to 20th at Earls Court, London.

Air and Water

LLOYD'S REGISTER.—At the December special meeting of the general committee of Lloyd's Register of Shipping, Major-General C. A. L. Dunphie, C.B., managing director, engineering works and shipyards, Vickers-Armstrongs, Ltd.; Mr. J. W. Platt, managing director of Anglo-Saxon Petroleum Company, Ltd.; and Mr. W. F. Wackrill, managing director of Esso Transportation Company, Ltd., were elected members of the committee.

DARTFORD-PURFLEET TUNNEL.—The Minister of Transport and Civil Aviation was asked in Parliament last week for a statement on the result of the traffic check which had been taken to assess the current needs for the completion of the Dartford-Purfleet tunnel. In his reply, the Minister said that the figures submitted by the highway authorities concerned indicated that on the day of the census 6400 vehicles a day might have used the tunnel. The figures were being further checked and examined.

Miscellanea

GEELONG REFINERY, AUSTRALIA.—A catalytic cracking unit of 650,000 tons per annum capacity is to be added to the Geelong refinery at Melbourne, Australia, of the Shell Petroleum Company, Ltd. The first stage of the refinery, a crude distillation unit, is expected to be completed in the spring of 1954.

SELLING PRICES FOR TUNGSTEN ORES.—The Ministry of Materials has announced that, as from December 18th, its selling price for tungsten ores of standard 65 per cent grade and ordinary quality has been reduced as follows : wolframite from £9 15s. to £9 5s., and scheelite from £9 to £8 10s. per long ton unit, delivered consumers' works.

A BOOKLET ON OIL.—We have received from the Anglo-Iranian Oil Company, Ltd., a booklet with the title "News in Pictures—1953," which depicts the activities of the company and shows the development of refineries at home and abroad, units of the tanker fleet and the production of oil in the various oilfields.

SYMPOSIUM ON GAS ABSORPTION.—The Midlands branch of the Institution of Chemical Engineers is to hold a symposium on " Gas Absorption " from Monday to Wednesday, April 5 to 7, 1954, at the University, Edgbaston, Birmingham. Inquiries concerning it should be addressed to the Chemical Engineering Department of the University.

KWINANA REFINERY.—To link the Kwinana refinery, now under construction for the Australian associate of the Anglo-Iranian Oil Company, Ltd., Australasian Petroleum Refinery, Ltd., with the port of Fremantle, Western Australia, two pipelines are being built, one of 6in diameter for white oils and the other of 12in diameter for black oils.

MR. F. H. B. HARRIS.—We have learned with regret of the death of Mr. F. H. B. Harris, formerly chief draughtsman of W. G. Bagnall, Ltd., Stafford, which occurred recently at Canterbury. Mr. Harris, who was eighty-two, joined W. G. Bagnall in 1932, and was for fifteen years assistant chief and chief draughtsman before retiring in 1947. He had formerly served for thirty-seven years on the staff of Kerr, Stuart and Co., Ltd., Stoke-on-Trent.

APPRENTICESHIP ON BRITISH RAILWAYS.—A brochure, entitled " Derby Locomotive Works Training School," has been prepared by British Railways for presentation to each boy starting as an apprentice trainee to give him a full knowledge of the training which he will undergo at Derby. This book describes in some detail the school, its organisation and administration, illustrates and lists the trades taught, and gives particulars of the conditions of admission and service, &c.

RETIREMENT OF MR. G. W. P. PAGE.—We learn that Mr. George W. P. Page, A.C.G.I., A.M.I.E.E., is retiring at the end of the year from the staff of the Publicity Department, the British Thomson-Houston Company, Ltd., Rugby. Mr. Page joined B.T.H. in 1923, having previously held editorial appointments on *Electrical Engineering* and in the Publicity Department of the General Electric Company, Ltd. As press liaison officer his chief responsibility has been the preparation of articles for the Press.

INSTITUTE OF METALS' AWARDS.—The council of the Institute of Metals has made the following awards of medals for 1954 :—Institute of Metals (Platinum) Medal to Dr. Leslie Aitchison, in recognition of his services to metallurgy in industry, in education and in public service ; and the Rosenhain Medal to Professor Alan Howard Cottrell, Professor of Physical Metallurgy, University of Birmingham, in recognition of his outstanding contributions to knowledge in the field of physical metallurgy, with special reference to the deformation of metals.

EXPORTS OF IRON AND STEEL.—Some iron and steel goods can be sent to any country except China, Hong Kong, Macao or Tibet without an export licence, provided that the value of the goods exceeds the value of the iron or steel content calculated at the rate of £30 per ton. The Board of Trade has now announced that as from December 21st this rate has been reduced to £20. The goods involved are those specified in Group 6 (2) of the First Schedule to the Export of Goods (Control) (Consolidation) Order, 1953. Inquiries about the matter should be made to the Export Licensing Branch, Board of Trade, Atlantic House, Holborn Viaduct, London, E.C.1.

CORROSION OF IRON AND STEEL.—Methods of protecting iron and steel against corrosion will be demonstrated at a public exhibition to be held in the Great Hall of the Battersea Polytechnic, London, from 10 a.m. to 4.30 p.m. on Friday, January 22nd. The exhibition will be on view during the preceding day to members of the corrosion group of the Society of Chemical Industry, by whom it is being organised. About thirty exhibits will demonstrate the most important methods and processes for the prevention of corrosion of iron and steel in five main sections as follows : effect of design ; treatment of the corrosive medium ; cathodic protection ; protective coatings ; and tests and methods of testing. Admission is free, and no tickets will be necessary.

PHYSICS OF PARTICLE SIZE ANALYSIS.—The Institute of Physics is arranging a conference on " The Physics of Particle Size Analysis," to be held in Nottingham from April 6 to 9, 1954. Subjects to be dealt with at the various sessions include : the motion of particles in fluids ; the scattering of light by particles ; the general phenomena encountered in particles size analysis ; the comparison of methods ; and the automatised methods of particle counting and sizing. Preprints of the papers to be presented to the conference will be available beforehand and, together with a summary of the discussion, will, in due course, be issued as a supplement to the *British Journal of Applied Physics*. Further particulars may be obtained from the Institute of Physics, 47, Belgrave Square, London, S.W.1.

CARBON DIOXIDE AS A COOLANT.—The new " CeDeCut " technique of using carbon dioxide as a tool coolant was demonstrated at the opening of the East Kilbride factory of Rolls-Royce, Ltd. The method demonstrated and the apparatus used were developed by the Carbon Dioxide Company, Ltd., in association with the Central Research Department (Engineering Section) of the Distillers Company, Ltd. It is stated that production tests with the new technique have given most encouraging results, particularly in dealing with the modern tough and heat-resistant alloys, including " Nimonic " and nickel-chrome molbydenum steels. The chief advantages claimed are very substantial increases in tool life, enhanced cutting speeds and improvements in surface finish, and the technique has been adapted to most of the common machining operations, including the regrinding of tools. We are informed that a pamphlet on the method and its application to machining generally is now being prepared by the Carbon Dioxide Company, Ltd., and will be available for distribution to the engineering industry in January next. Inquiries should be addressed to the Carbon Dioxide Company, Ltd., Great Burgh, Epsom, Surrey.

EXPORTS IN A BUYER'S MARKET.—The full report has now been published of the Federation of British Industries export sales conference held at Buxton at the end of October. The object of the conference was to discuss, in view of present conditions, ways in which industry could help itself to increase exports. About 120 members of the F.B.I., together with representatives of banks, merchant houses and national organisations concerned with export or salesmanship, attended the conference which, after opening speeches by Sir Harry Pilkington and Sir William Rootes, chairman of the Dollar Exports Council, divided into five discussion groups. The main points covered in these discussions are summarised in the report under the following heads :—Export opportunities, organising for export, relations between exporter and importer, the export sales force, and export promotion. Although the conference was concerned with specific practical issues, the discussions also threw fresh light on questions of major policy, including the need for the widest possible spread of overseas markets, the diminishing value of Government appeals for priority to be given to particular markets, and capital investment overseas as a means of expanding world trade. It is stated that " follow-up " action is being considered by the F.B.I. and other bodies on the numerous practical points raised at the conference. The report, price 3s. 6d., can be obtained from the Federation of British Industries, 21, Tothill Street, London, S.W.1.

ROYAL SOCIETY OF ARTS PRIZES.—The Royal Society of Arts, as trustee for the relevant endowments, offers various prizes during the year 1954. They include the Benjamin Shaw prize for industrial safety, which arises from a trust founded in 1876 "for the promotion of improvements in all matters relating to unhealthy and dangerous occupations," a subject in which the Royal Society of Arts has taken a practical interest ever since its foundation in 1754. A prize of £20 is offered in 1954 in accordance with the terms of the trust " for any discovery, invention, or newly devised method of obviating, or materially diminishing any risk to life, limb or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Entries may be in the form of descriptive essays or models. Another is the Fothergill prize for fire prevention or fire fighting, £20 being offered in 1954 for a descriptive essay or model embodying some new idea for the prevention or suppression of fire. Finally, there is the Howard prize for mechanical motive power. The Howard Trust was established in 1868 for the purpose of making awards periodically to the authors of treatises on steam or other motive agents, and a prize of £20 will be awarded in 1954 to the author of a treatise on some aspect of the subject of mechanical motive power. Entries for these prizes must be received by the Secretary of the Royal Society of Arts, 6/8, John Adam Street, Adelphi, London, W.C.2, not later than July 31, 1954. Full details and conditions of entry are available at that address.

Launches and Trial Trips

ROYAL ARROW, oil tanker ; built by the Netherlands Dock and Shipbuilding Company, Amsterdam, for Rispond Tankers, Ltd.; length between perpendiculars 630ft, breadth moulded 86ft, depth 45ft, draught summer freeboard 34ft, deadweight 31,000 tons, trial speed 16·9 knots ; thirty cargo oil tanks ; one set of N.D.S.M.-Parsons double reduction geared turbines, 15,000 s.h.p., take steam at 600 lb per square inch and 800 deg. Fah. from two Babcock and Wilcox boilers ; two 500kW turbo-generators. Launch, December 12th.

NEPTUNE, cargo ship ; built at the Neptune yard of Swan, Hunter and Wigham Richardson, Ltd., for the Compania Naviera Hesperia S.A., Panama ; length between perpendiculars 435ft,, deadweight 10,000 tons on 26ft 5in draught, service speed 13½ knots ; five cargo holds, derrick complement includes ten 10 tons, one 50 tons, one 20 tons steam deck machinery ; Swan, Hunter-Doxford oil engine, four cylinders 670mm diameter by 2320mm combined stroke, 4400 b.h.p. at 115 r.p.m., two cylindrical multitubular boilers, two 35kW steam-driven generators, one 31kW diesel-driven generator. Trial, December 15th.

DUNDEE, cargo ship ; built by the Burntisland Shipbuilding Company, Ltd.. for the Dundee, Perth and London Shipping Company, Ltd.; length between perpendiculars 251ft, breadth moulded 43ft, depth moulded to shelter deck 29ft 2in, draught loaded 18ft 11in, deadweight 2950 tons, speed 11 knots, two cargo holds, hydraulically driven winches, six passengers; British Polar diesel engine, nine cylinders 340mm diameter by 570mm stroke, 1640 b.h.p., three 90kW diesel-driven generators. Launch, December 18th.

NORWEST, oil tanker ; built by Smith's Dock Company, Ltd., for the Bergen Kulkompani A/S, Bergen ; length between perpendiculars 315ft, breadth moulded 47ft 6in, depth moulded to harbour deck 21ft 3in, deadweight 4000 tons on 19ft 6in draught, service speed 11¼ knots, six centre tanks, eight wing tanks, trunk over cargo tanks, one pump room, two 250 tons per hour cargo oil pumps ; No. 7 Fredriksstad steam motor, 1600 i.h.p., three oil-fired forced draught cylindrical multitubular boilers supply steam at 220 lb per square inch. Launch, December 19th.

MELIKA, oil tanker ; built by the Furness Shipbuilding Company, Ltd., for the Afran Transport Company, of Liberia ; length between perpendiculars 630ft, breadth moulded 87ft, depth moulded 45ft 6in, deadweight 32,000 tons on 34ft 2in Lloyd's summer draught, trial speed 15¼ knots ; thirty cargo oil tanks, one pump room, four 4500 U.S. gallons per minute turbo cargo pumps, two 500kW turbo-alternators, one 100kW diesel-driven alternator ; one set of double reduction geared turbines built by Richardsons, Westgarth and Co., Ltd., normal power of 12,500 s.h.p. at 105 r.p.m. and maximum of 13,750 s.h.p. at 108 r.p.m.; steam supplied at 600 lb per square inch and 850 deg. Fah. by two Foster-Wheeler " D " pattern boilers. Launch, December 20th.

Personal and Business

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., states that its Middlesbrough office has been transferred to Prudential Chambers, 27, Albert Road, Middlesbrough.

MR. H. J. MANZONI, M.I.C.E., city engineer and surveyor of Birmingham, has become a member of the board of governors of the Loughborough College of Technology.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., announces the appointment of Mr. A. J. Davies as district engineer, erection department, Cardiff, following the retirement of Mr. T. L. Hutchinson. Mr. Hutchinson is being retained as a part-time consultant.

THE PLESSEY COMPANY, Ltd., Ilford, Essex, states that Mr. J. A. Clark and Mr. M. W. Clark have been appointed directors. Mr. J. A. Smith has retired from the board, on account of ill health. Mr. W. F. Cross has been appointed joint secretary of the company.

DUNLOP RUBBER COMPANY, Ltd., announces the following appointments in its general rubber goods division : Mr. S. A. Mousley, general sales manager ; Mr. P. A. Bridge, sales manager of the mechanical group ; and Mr. A. B. Rankine, sales manager of the domestic group.

THE CONE AUTOMATIC MACHINE COMPANY (GREAT BRITAIN), Ltd., has been formed as a subsidiary of the Cone Automatic Machine, Inc., Windsor, Vermont, U.S.A., to take responsibility for manufacturing automatic bar machines. Mr. Louis P. Carter has resigned his directorships of the Churchill group of companies to become managing director of the new company, the temporary address of which is Solihull Chambers, 14, High Street, Solihull, Birmingham. Charles Churchill and Co., Ltd., will continue to act as agents in Great Britain for Cone automatics.

HUNTING AIR TRANSPORT, Ltd., has changed its name to Hunting-Clan Air Transport, Ltd., subsequent to the setting up of Hunting-Clan Air Holdings, Ltd. This brings into effect an agreement between the Hunting Group of Companies and the Clan Line Steamers, Ltd., whereby a new partnership is formed with equal interest in certain aviation companies, including Hunting-Clan Air Transport, Ltd. The companies continue under their present management with the addition to their boards of representatives of Clan Line Steamers, Ltd., in the case of the air transport company, these being the Hon. Anthony Cayzer and Mr. J. A. Thomson.

British Patent Specifications

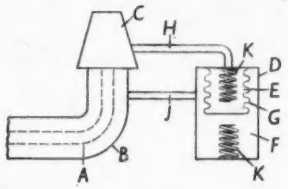
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application: the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

ELECTRICAL ENGINEERING

696,748. April 17, 1952.—HIGH-TENSION PRESSURE CABLE INSTALLATIONS, Felten and Guilleaume Carlswerk, Aktiengesellschaft, of Köln-Mülheim, Germany.

The drawing illustrates one arrangement of a high-tension pressure cable installation. The arrangement at each end of the cable is fundamentally the same. *A* is the cable installed in the pressure pipe *B*, which is filled with a compressed gas. The cable is closed by an end cap *C*. The equalising container *D* is



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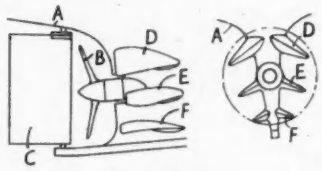
divided into the chambers *E* and *F* by an impermeable diaphragm *G*. The space *E* is connected by a pipe *H* with the filling of impregnating means in the end closure *C*, and the space *F* is connected through a pipe *J* with the pressure pipe *B* of the cable. Springs *K* are mounted in the equalising container *D*. Thus the impregnating medium is held through an impermeable diaphragm under the pressure of the gas present in the pressure pipe of the cable.—*September* 9, 1953.

MARINE ENGINEERING

700,276. March 11, 1952.—THE PROTECTION OF SHIPS' PROPELLERS, Nils Johannes Liaaen, Borgundveien 17B, Alesund, Norway.

The invention relates to ships' propellers and comprises a protection device to prevent damage by ice and other submerged or partly submerged objects, which might otherwise foul the propeller blades. As the drawings show, *A* is the aft end or stern of a ship, *B* the ship's propeller, and *C* the rudder.



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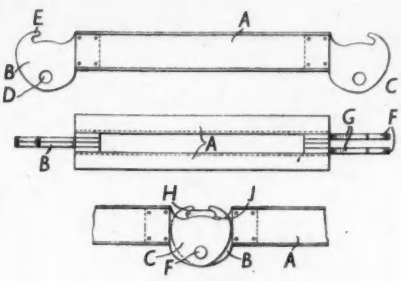
The protection device comprises the fin-shaped members *D*, *E* and *F*, which are arranged in pairs, one above the other on each side of the ship, and each of them is so dimensioned that at its aft end it extends out approximately in alignment with the circumscribed circle of the propeller. The fin members on each side of the ship are arranged approximately parallel one with the other, and inclined downwards from their fastenings to the hull to their outer edges. With this arrangement of the fin members the whole propeller area is well protected.—*November* 25, 1953

MINING ENGINEERING

700,002. August 2, 1949.—ASSEMBLING SUPPORTING BEAMS, Le Progrès Charbonnier "Prochar" Société Coopérative, 22, rue Saint-Jean, Anderlues, Belgium.

The invention relates to supporting beams which are placed in mines under the roof of the working faces and held by means of stanchions in order to form support frames. The supporting beam formed by a double beam *A* is provided at one end with a single jaw *B*, and at the other end with a double jaw *C*, which is designed to fit the single jaw of the adjacent supporting beam. The jaw *B* has at its lower part a hole *D* and at its upper part a hook *E*. The jaw *C* is symmetrical with it. When the jaw of one beam is engaged in that of the adjacent beam, the holes coincide and are coupled by a bolt *F*. Between the facing hooks *E* is set a wedge-shaped fixing key *G*, *H*. This key is pushed in as far as the distance between the hooks will allow, the distance being determined by the shape of the roof to be supported. In order that the contact between the key and the jaws shall always be ensured under the best conditions, it is necessary that their contact surfaces should fulfil certain conditions, and, in particular, that the lower face of the key, and the lower surfaces of the jaws serving it as seating, should be curved and concentric with the axis of articulation.



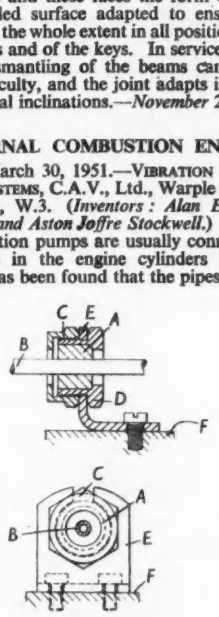
No. 700,002

As shown, the lateral cheeks *H* of the key and the corresponding faces *J* of the hooks are cylindrical. The best results are obtained, however, by giving these cheeks and these faces the form of a helicoid or other ruled surface adapted to ensure intimate contact over the whole extent in all positions of service of the beams and of the keys. In service the assembling and dismantling of the beams can be effected without difficulty, and the joint adapts itself to roofs with the usual inclinations.—*November* 25, 1953.

INTERNAL COMBUSTION ENGINES

700,117. March 30, 1951.—VIBRATION DAMPER FOR PIPE SYSTEMS, C.A.V., Ltd., Warple Way, Acton, London, W.3. (*Inventors: Alan Ewart Walter Austen and Aston Joffre Stockwell.*)

Fuel injection pumps are usually connected to the fuel nozzles in the engine cylinders by threaded unions. It has been found that the pipes are liable to



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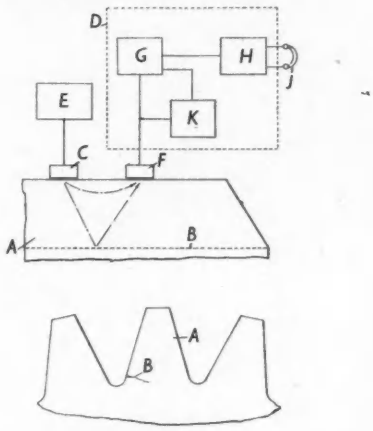
fracture due to the strains set up by vibrations when the engine is in motion. The object of the invention is to minimise this risk in a simple manner. Referring to the drawings, there is provided a collar *A* made from soft rubber or rubber-like material, which is slipped over a pipe *B*. The collar is mounted in any convenient socket holder secured to a rigid support. As shown the holder comprises a pair of hollow parts *C* and *D*, screwed together, and a bracket *E* secured to a support *F* by screws. The damper is placed in any suitable position on the pipe between its ends and preferably at an anti-nodal position where it can exert its maximum vibration-damping action. A modified arrangement for twin fuel pipes is also shown in the specification.—*November* 25, 1953.

METALLURGY

699,796. March 24, 1950.—THE DETECTION OF CRACKS IN ENGINEERING COMPONENTS, The Parsons and Marine Engineering Turbine Research and Development Association, Pametrada Research Station, Wallsend. (*Inventor: Henry George Yates.*)

The invention relates to the detection of cracks in engineering components such as gear wheel teeth. Referring to the lower drawing, the gear wheel shown is of typical form, and one of the teeth *A* has a transverse crack *B* near to its root. In the upper view a side elevation of the cracked tooth is shown together with one form of mechanism for producing an audible indication of the crack. This consists of a pulsed quartz crystal *C* and an electronic receiving mechanism *D* designed to complete a circuit on the receipt of impulses at a suitable rate and produce an audible sound in a pair of earphones or other acoustic device. The crystal *C* is controlled by electronic means, such as a pulsed oscillator *E*, so as to apply impulses to the surface of the gear tooth at a repetition rate sufficiently high to constitute an audible sound while the crystal *F* of the receiver *D* is applied by means of some movable device to the surface of the tooth near to the point of action of the transmitting crystal *C*. With this arrangement the first pulse to reach the receiver, due to the action of the transmitting crystal *C*, will travel directly through the tooth *B* to the crystal *F* and thence to the electronic time delay *K* which completes the receiver circuit by causing the electronic gate *G* to open, thus allowing subsequent pulses to reach the amplifier *H* and earphones *J*. The time delay circuit *K* also causes the gate *G* to close after a predetermined short time, which may be adjustable, so that a later pulse, such as would be received from a remote boundary of the gear, is prevented from reaching the earphones.



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If now a pulse subsequent to the initial one is reflected from a crack such as *B*, this pulse will be permitted to reach the earphones *J*, but if no such pulse arrives within the predetermined short time, as would be the case if no crack exists, the electronic gate *G* in the receiver will have been automatically closed so that no pulse reaches the earphones. The stimulating pulses are applied at such a repetition rate as to allow the effect of each pulse to die away between successive pulses, so that a clearly audible response will be obtained when reflected pulses due to the presence of a crack arrive in time to be received. A suitable gate-opening and delayed gate-closing circuit is also shown in the specification.—*November* 18, 1953.

700,224. October 10, 1951.—TOP BLAST STEEL REFINING PROCESS, Demag Aktiengesellschaft, Werthauser Strasse 64 (22a), Duisburg, Germany.

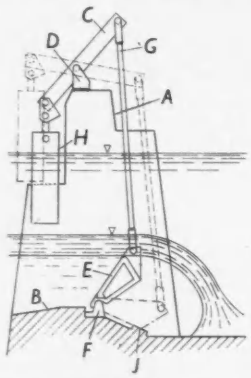
In the top blast refining process in the production of steel, pure oxygen is blown from above vertically, or almost vertically, at high pressure and high speed on to the bath through a nozzle, the jet of oxygen always impacting the bath at the same position. According to the invention, it is proposed that the end of the oxygen feed pipe be moved during the process in such a way that the oxygen is distributed as uniformly and widely as possible throughout the whole bath. Due to the uniform distribution of the refining action thus obtained throughout the bath, local over-refining is prevented; furthermore, by avoiding the overloading of portions of the bath with iron oxides, the brickwork of the refining vessel is to a great extent preserved, for it is known that slags having a high content of iron oxide attack and damage the brickwork very considerably.—*November* 25, 1953.

WATER TURBINES

700,320. May 11, 1951.—AUTOMATIC WEIR ARRANGEMENT FOR THE TAIL-RACE OF A HYDRAULIC REACTION TURBINE, The English Electric Company, Ltd., Queen's House, 28, Kingsway, London, W.C.2. (*Inventor: Paul Werner Seewer.*)

The invention has the object of controlling the level of the water in the tail-race. As shown in the drawing, on the piers *A* flanking the tail-race *B* balance beams *C* are pivoted on brackets *D*. A screen *E* is pivoted on a knuckle joint *F* on the bottom of the tail-race and is linked to the downstream ends of the balance beams by means of rods *G*. To the upstream ends of the beams *C* a counterpoise *H* is linked so that it can be submerged to a varying degree in the water flowing off through the tail-race, the level of which varies between the high water level and the permissible low water level as shown. When the water level in the tail-race rises to such an extent, the counterpoise is at least partly submerged in the water, the counterpoise loses so much in weight by the principle of archimedic buoyancy, that it no longer balances the weight of the screen *E* and the thrust of the water flowing over. The screen drops into the position shown in chain dotted lines, where it passes into a slope or recess *J*

in the bottom of the tail-race. When the water level in the tail-race drops so far that the counterpoise is not sufficiently submerged it overbalances the screen and raises it to the position shown in full lines in which the water is dammed up in the tail-race at least to the minimum low water level. The rises in



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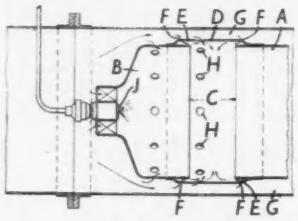
tail-race levels in times of flood are therefore no more than would occur if the weir were non-existent. If flood levels in the tail-race recede the counterweights are no longer submerged, thus re-establishing automatically the desired safe minimum tail-race level.—*November* 25, 1953.

GAS TURBINES

700,017. March 5, 1951.—COMBUSTION CHAMBERS, Joseph Lucas (Industries), Ltd., formerly known as Joseph Lucas, Ltd., Great King Street, Birmingham. (*Inventor : Eric Samuel Collinson.*)

The invention relates to air-jacketed liquid-fuel combustion chambers for jet engines, or gas turbines, its object being to minimise the formation of soot deposits on the peripheral surface of such a chamber in the region adjacent to the fuel burner. Referring



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to the drawing, the combustion chamber is made from two coaxial parts *A* and *B*, of substantially equal diameter, the adjacent ends of which are separated by a gap *C* corresponding in width and position to the region on which soot is liable to be deposited. The two parts are united by a sleeve *D* of larger diameter. The sleeve is made longer than the width of the gap and its ends are reduced in diameter to embrace the parts *A* and *B*. Each part extends within the sleeve sufficiently to form with it an annular air passage *E*, and apertures *F* are formed at or near the ends of the sleeve through which air can flow from the jacket *G* along the passages to the gap and thence into the combustion chamber. Other apertures *H* may also be formed in the sleeve to admit air from the jacket directly into the gap *C*. By means of the construction described, the liability to the formation of a soot deposit around the inner peripheral surface of the combustion chamber in the region adjacent to the burner *J*, can, it is claimed, be minimised in a simple and satisfactory manner.—*November* 25, 1953.

Technical Reports

National Building Studies Research Paper, No. 18. *Investigations on Building Fires, Part VI. The Fire Resistance of Reinforced Concrete Columns.* H.M. Stationery Office. Price 3s.—This report describes an investigation of the relationships between the fire resistance of reinforced concrete columns and the applied load, the concrete strength, the column size, and the design of the reinforcement. The columns tested were square in cross section and varied in thickness from 8in to 19in. Portland cement and gravel aggregates were proportioned to give cube strengths varying from 2250 lb per square inch to 5000 lb per square inch at an age of twenty-eight days. The columns matured for periods varying from seven months to two years nine months.

Under test the columns had a length of 10ft exposed to a furnace while a load was applied hydraulically. The tests were carried out in accordance with the standard fire resistance test procedure specified in British Standard 476, with the exception that the specimens were tested until collapse and the water test and reloading test omitted for this purpose. The investigation has yielded much information on the effect on the fire resistance of reinforced concrete columns of such factors as applied load, concrete strength, column size, and the method of reinforcing the concrete.

Thermal Decomposition of Organic Insulating Materials in Relation to the Mechanism of Tracking (Ref. L/T274). By V. E. Yarsley, W. J. Grant and G. C. Ives. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 12s., postage 3d.—Hitherto the subject of tracking has been considered mainly from a practical point of view, with the result that there is on record a large amount of essentially empirical information. The work here described approaches the subject from a different angle in an endeavour to determine the fundamental issues involved. As a first step in that direction a study has been made of thermal decomposition and the characteristics of the decomposition products of relevant materials. After reviewing the literature of the subject the report gives an account of some experiments made to extend the more promising of the recorded proposals and shows the bearing of the results upon tracking phenomena.

The Self-Excitation of Capacitor Compensated Induction Motors (Ref. Q/T138). By J. A. Nicholson, M.Sc. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 6s., postage 3d.—In the selection of capacitors for individual power factor correction of induction motors, care must be taken to avoid self-excitation when the motor is disconnected from the supply. This may be done by restriction of the capacitor current to 85 per cent of the motor no-load current. The mechanism of self-excitation is described and the details of experimental verification are quoted.

Characteristics of a Small Heat Pump Installation (Ref. Y/T15). By M. V. Griffith, B.Sc., F.Inst. P., and H. J. Eighteen, A.I.Mar.E. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 15s., postage 4d.—Details are given of a small installation constructed from components of a heat pump taken from a German submarine. The performance under various conditions of use covering those likely to be met with in several practical applications has been investigated. Water was used as the source of low-grade heat in all the tests described.

The Shinfield Heat Pump. Interim Report (Ref. Y/T20). By M. V. Griffith, B.Sc., F.Inst.P., and H. G. Eighteen, A.I.Mar.E. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 6s., postage 3d.—This report describes a 10 h.p. heat pump for heating a laboratory building and gives data obtained in the first season's operation. A comparison is made with the performance of a gas boiler used simultaneously to heat an adjacent laboratory building of similar construction and size.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases, the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Jan. 6th.—LONDON SECTION : School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1, "Engineering Design of V.H.F. Multi-Channel Telephone Equipment," W. T. Brown, 6.30 p.m.

Thurs., Jan. 7th.—SCOTTISH SECTION : Department of Natural Philosophy, The University, Edinburgh, "Radio Astronomy," H. Seddon, 7 p.m.——N.W. SECTION : College of Technology, Manchester, "The Manchester University Computer," D. B. G. Edwards, 7 p.m.——MERSEYSIDE SECTION : Electricity Service Centre, Whitechapel, Liverpool, 1, "Interlacing Problems in Television Receivers," G. N. Patchett, 7 p.m.

INSTITUTE OF FUEL

Tues., Jan. 12th.—Waldorf Hotel, Aldwych, London, W.C.2, "New Carbonisation Processes under Development and their Relation to Established Practice," D. T. Barritt and T. Kennaway, 5.30 p.m.

INSTITUTE OF METALS

Wed., Dec. 30th.—BIRMINGHAM LOCAL SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, "Metals in Telecommunications," C. E. Richards, 6.30 p.m.

Tues., Jan. 5th.—OXFORD LOCAL SECTION : Cadena Café, Cornmarket Street, Oxford, "Industrial Methods of Electroplating," G. E. Gardam, 7 p.m.

Wed., Jan. 6th.—INFORMAL DISCUSSION : The University, Edgbaston, Birmingham, "Lubricants for Metal-Working Operations in the Non-Ferrous Metal Industries," 10.30 a.m.

Thurs., Jan. 7th.—LONDON LOCAL SECTION : 4 Grosvenor Gardens, London, S.W.1, "The Rogerstone Strip Mill," F. King, 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Jan. 5th.—EASTERN CENTRE : Swan Hotel, Bedford, "Vehicle Maintenance from the Aspect of Safety," A. H. Duck and J. H. Vincent, 7 p.m.

Fri., Jan. 8th.—S. WALES GROUP : S. Wales Institute of Engineers, Cardiff, "The Cost of Vehicle Maintenance," H. Rossington 7 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Jan. 5th.—Geological Society, Burlington House, Piccadilly, London, W.1, "Some Mechanical Handling Problems in the Chemical Industry," J. Johnston, 5.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Jan. 5th.—WORKS MEETING : Great George Street, Westminster, London, S.W.1, "Swedish Underground Hydro-Electric Power Stations," J. F. Hagrup, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Jan. 4th.—S. MIDLAND CENTRE : James Watt Memorial Institute, Great Charles Street, Birmingham, Discussion on "Technical Education of Non-National-Certificate Students," opened by J. Ashmore and D. I. Meyrick, 6 p.m.

Tues., Jan. 5th.—MEASUREMENTS SECTION : Savoy Place, Victoria Embankment, London, W.C.2, "A Scaling Unit Employing Multi-Electrode Cold-Cathode Tubes," and "A Sensitive Pulse Trigger Circuit with a Stable Threshold," K. Kandiah ; "The Development of a Neutron Spectrometer for the Intermediate Energies," F. S. Goulding, J. C. Hammerton, M. G. Kelliher, A. W. Merrison and E. R. Wiblin, 5.30 p.m.——N. MIDLAND CENTRE : British Electricity Authority, Whitehall Road, Leeds, 1, "Voltage Transformers and Current Transformers Associated with Switchgear," W. Gray and A. Wright, 6.30 p.m.

Wed., Jan. 6th.—TEES-SIDE SUB CENTRE : Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, "Electrical Hazards," "Electrical Safety" D. A. Picken, 6.30 p.m.

Thurs., Jan. 7th.—ORDINARY MEETING : Savoy Place, London, W.C.2, Parsons Memorial Lecture, "Continuity of Electricity Supply," H. Leyburn, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Mon., Jan. 4th.—E. MIDLANDS BRANCH, GRADUATES' SECTION : College of Technology, Leicester, "Modern Methods Adopted in Power Station Installations," D. E. Challener, 7.15 p.m.——S. WALES BRANCH, GRADUATES' SECTION : Y.M.C.A. Buildings, Kingsway, Swansea, "The Utilisation and Distribution of Compressed Air in Mines," D. J. Davies, 7 p.m.

Wed., Jan. 6th.—AUTOMOBILE DIVISION : Storey's Gate, St. James's Park, London, S.W.1, "The Future Development of the National Certificate and Diploma Courses," 6.45 p.m.

Thurs., Jan. 7th.—EASTERN BRANCH, GRADUATES' SECTION : Town Hall, Luton, "Taper Roller Bearings," F. J. Wren, 7.30 p.m.——YORKSHIRE BRANCH, GRADUATES' SECTION : Technical College, Huddersfield, "Organising for 12 Off," W. R. Gaudion, 7.30 p.m.

Fri., Jan. 8th.—GENERAL MEETING : Storey's Gate, St. James's Park, London, S.W.1, "An Experimental Investigation into the Effect of Fuel Addition to the Intake Air on Performance of a Compression-Ignition Engine," W. T. Lyn ; "The Effect of Auxiliary Fuels on the Smoke-Limited Power Output of Diesel Engines," L. D. Derry, E. M. Dodds, E. B. Evans and D. Royle, 5.30 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Wed., Jan. 6th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, "Telex Service," R. N. Renton, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Wed., Jan. 6th.—NOTTINGHAM SECTION : Victoria Station Hotel, Milton Street, Nottingham, "The Production Engineer and his Relations," J. H. Bingham, 7 p.m.——WOLVERHAMPTON SECTION : Technical College, Wolverhampton, "Application of Hydraulic Power as an Aid to Productivity," F. B. Levetus, 7.15 p.m.

INSTITUTION OF SANITARY ENGINEERS

Thurs., Jan. 7th.—Caxton Hall, Westminster, London, S.W.1, Induction of E. H. Vick as President for 1954, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

Wed., Jan. 6th.—MIDLAND SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, Chairman's Address, "Brewing and Distilling," T. F. Luck, 7 p.m.

Fri., Jan. 8th.—Townsend House, Greycoat Place, London, S.W.1, "A Modern Vehicle Actuated Detector and its Development," H. J. N. Riddle, 7 p.m.

REINFORCED CONCRETE ASSOCIATION

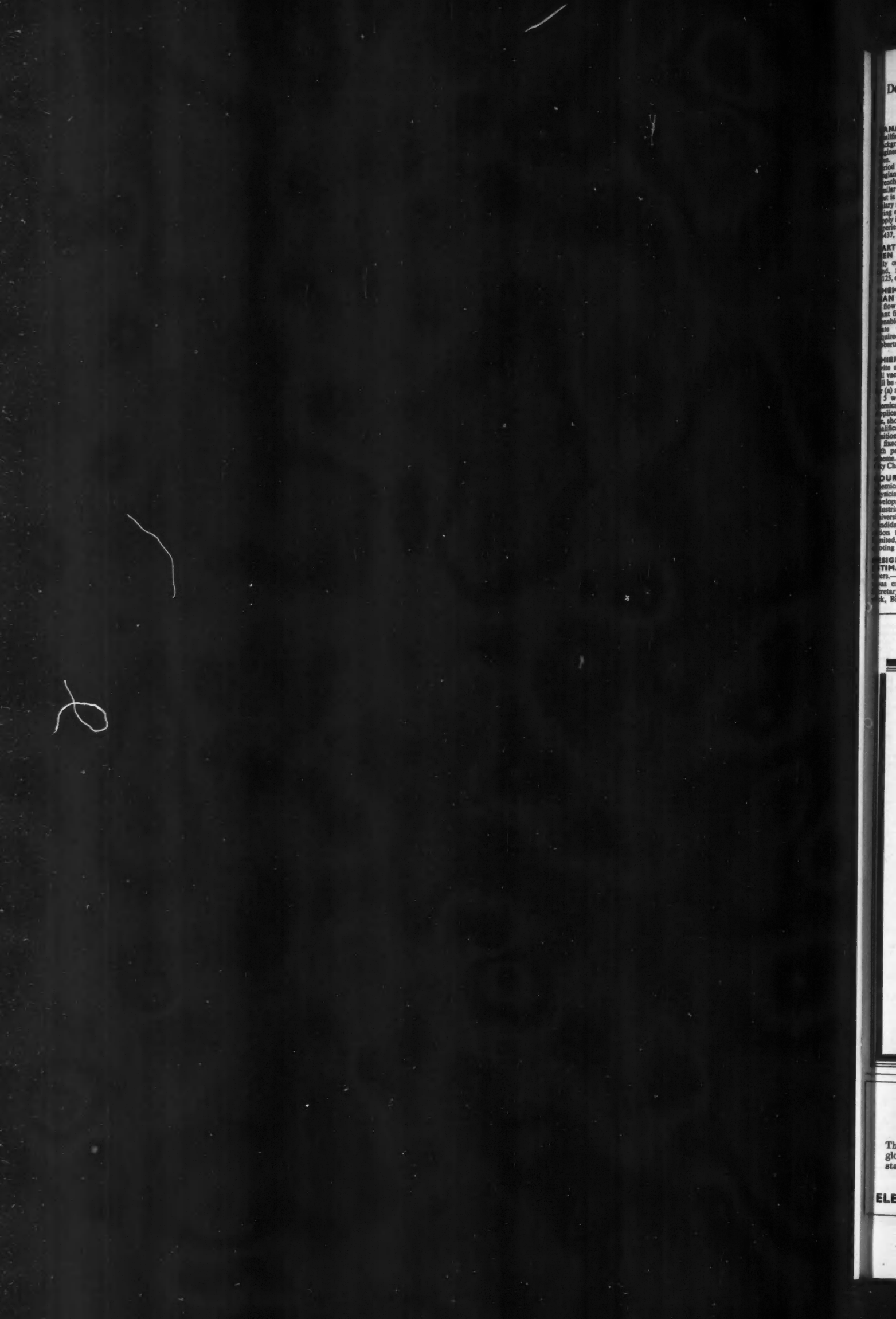
Tues., Jan. 5th.—N.W. BRANCH : College of Technology, Sackville Street, Manchester, 1, "Concreting Methods and Machinery," A. P. Lambert, 6.45 p.m.

Wed., Jan. 6th.—Liverpool Engineering Society, 24, The Temple, Dale Street, Liverpool, "Concreting Methods and Machinery," A. P. Lambert, 6.30 p.m.

ROYAL AERONAUTICAL SOCIETY

Thurs., Jan. 7th.—MAIN LECTURE : Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, Lecture to Young People, "The Fun of Finding Out in Flying," Sir Leonard Bairstow, 6 p.m.

END OF VOL. 196



SITUATIONS VACANT

ANADA.—An excellent opportunity exists for a alified Electrical Engineer with a sound practical ckground in electricity and mechanics as a service gineer for industrial electric trucks in the Montreal ea. He should be prepared to emigrate after a riod of training at the manufacturers' factory in gland and should speak French fluently. Non-ench-speaking applicants will be considered for a nilar post in the Toronto district of Canada, which st is likely to become vacant a little later in 1954. lary in Canada 4500 dollars per year. Reasonable ing expenses refunded whilst training in England. ply in own handwriting, giving details of age, past perience, qualifications, present salary.—BOX No. 437, "The Engineer." A

ARTOGRAPHIC OR SURVEY DRAUGHTS-EN (good Maths.) or Assistant Surveyors, for ty office. Good salary and training. Pension nd, five-day week, free lunches.—Write, BOX 123, c/o 191, Gresham House, E.C.2. E6523 A

HEMICAL PLANT SENIOR DRAUGHTS-AN required for East London factory. Experience flow diagrams, general arrangement and detailing nat from design engineers' data. Permanent pen-nable position with excellent working conditions. ate technical training, experience and salary uired.—Apply to Personnel Manager, A. Boake, berts and Company, Limited, London, E.15. E6490 A

HIEF ENGINEER.—Brotherton and Co., Ltd., ite applications for this post which will shortly l vacant at their head office. The Chief Engineer ll be directly responsible to the production director : (a) supervision of plant and building maintenance 5 works ; (b) design and construction of new mical plants ; (c) development of existing plants. plicants, preferably between 40 and 50 years of , should have high civil or mechanical engineering alifications with successful experience in responsible itions in the chemical industry. The salary will fixed by agreement according to qualifications, h participation in contributory superannuation eme.—Applications to the Personnel Manager, y Chambers, Leeds, 1. E2996 A

OURTAULDS, LIMITED, has a vacancy in its emical Engineering Section in Coventry for a ysicist or Engineer, with experience of design and velopment of new instruments for application in ustrial plant. Candidates should have a good iversity Degree or an equivalent qualification.— ndidates should write for a detailed form of appli-ion to the Director of Personnel, Courtaulds, mited, 16, St. Martin's-le-Grand, London, E.C.1. oting the reference number D.47. E6483 A

ESIGN DRAUGHTSMAN/TECHNICAL TIMATOR required by large pump manufac-ers.—Apply, giving full details of training, pre-us experience, age, &c., in confidence, to the cretary, Tangyes, Ltd., Cornwall Works, Smeth-k, Birmingham. E6508 A

CIVIL ENGINEERS AND DESIGNERS required in consulting engineer's office as follows :—
(1) DESIGNERS experience in reinforced concrete structures. Salary from £600 per annum.
(2) GRADUATE and JUNIOR ENGINEERS, for design of civil works. Salary from £390 per annum.
Commencing salaries given above will be increased according to qualifications and experience.—Applications, with references to previous employers and stating which post being applied for, to be sent to Sir William Halcrow and Partners, Stanhope House, 47, Park Lane, London, W.1. E6479 A

DEPUTY PLANNING MANAGER required for London factory engaged in pressed steel fabrications for the motor industry. Good all-round experience ; must be capable administrator with ability to co-ordinate jig and press tool design, production planning and layout of production sections. This will be a progressive executive position eligible for participation in the company's staff pension scheme. Write, giving full details of experience, age and salary required.—BOX No. E3028, "The Engineer." A

DESIGNER-DRAUGHTSMAN required for large works in North Lincolnshire. Applicants must have good technical qualifications, experience in design of plant for iron and steel works would be an advantage. Permanent situation with good prospects for a first-class man with initiative. Apply, stating age, full details of previous experience and salary required.—BOX No. E6454, "The Engineer." A

DESIGNER-DRAUGHTSMAN required immediately by Bell Punch Co., Ltd., Uxbridge, for design and development of varied mechanical and electro-mechanical equipment for office and cash control machines. Must possess ability to work from schematic sketches and produce complete drawings for prototype construction.—Apply by letter, giving full details of age, experience, qualifications, and salary required, to the Personnel Department. E6499 A

DESIGNER-DRAUGHTSMAN with first-class experience of small clockwork mechanisms, required in London for development work on photographic shutters. Salary in accordance with experience. Please give fullest particulars when applying.—BOX No. E3018, "The Engineer." A

DESIGNER-DRAUGHTSMEN are required by the David Brown Gear Group of Companies. Particularly useful will be the knowledge of gears and their application in the automobile and general industry. Although there is no age limit, applicants are requested to mention their age in addition to full description of experience and salary requirements. These will be monthly appointments, offering good salaries, pension, life assurance and sickness benefits and good working conditions.—Men with technical training and a minimum of 10 years' experience, are asked to write to the Chief Personnel Superintendent, David Brown and Sons (Huddersfield), Ltd., Park Gear Works, Huddersfield. E6489 A

DRAUGHTSMAN required, preferably experienced in roadmaking and contractors' machinery.—Apply, stating age, experience and salary required, to Thomas Green and Son, Ltd., Smithfield Ironworks, Leeds, 2. E3017 A

DRAUGHTSMEN and several Senior and Intermediate Structural Draughtsmen required at Battersea and Westminster. Salaries paid commensurate with experience and ability, pension scheme and bonus.—Write, stating age, experience and salary required, to Dawnays, Limited, Steelworks Road, Battersea. E2988 A

DRAUGHTSMEN, MECHANICAL ENGINEERING.—Draughtsmen wanted, experience of woodworking machinery and machine tools not essential.—Apply, giving details of age, experience and qualifications, to Personnel Manager, Wadkin, Ltd., Green Lane Works, Leicester. E3006 A

DRAUGHTSMEN required with sound experience of heating and ventilating work. The vacancies are in London. Excellent salary, and an additional subsistence allowance, also pension scheme. Apply, giving full details of experience and qualifications.—BOX No. E6517, "The Engineer." A

DRAUGHTSMEN, with sound experience of plant layout and special-purpose machinery, required for interesting work on long-term development programme. Work situated in Kent. Excellent salaries, subsistence allowance and pension scheme available. Apply with full particulars of experience and qualifications.—BOX No. E6516, "The Engineer." A

ELECTRICAL DESIGN ENGINEER, age 25–30, required. Minimum qualifications, University Degree in Electrical Engineering or Higher National Certificate. Knowledge of rolling mill electrical equipment and experience with large electrical manufacturing company essential.—Applications, stating age, qualifications, experience and salary required, should be sent to Personnel Officer, Davy and United Engineering Company, Limited, Park Iron Works, Sheffield, 4. E6484 A

ENERGETIC MAN required to take charge of the Reinforcement Department in the Cardiff office of T. C. Jones and Co., Ltd., whose local works are in the Rhondda. The successful candidate must have a good knowledge of design and detailing and should have experience of liaison between office, works and site on all types of reinforced concrete jobs. Good prospects await ambitious man willing to work hard and assist in building a rapidly expanding department. Five-day week, superannuation scheme, &c.—Reply to Personnel Department, T. C. Jones and Co., Ltd., 95, Wood Lane, London, W.12, stating age, experience and salary required. Interview in London or Cardiff. E6520 A

ENGINEER, mechanical, highest qualifications, full control established precision instrument works, expanding S. London ; 120 personnel. Able maintain very close limits and get output on production and short batch. Difficult assignment. First-class practical experience and organising flair. Usual opportunities with attractive starting salary and prospects.—BOX No. E6464, "The Engineer." A

ENGINEER required for laboratory situated Manchester for engine and rig testing of lubricants and fuels. Experience with electric and hydraulic dynamometers essential. Successful applicant will be required to work with minimum supervision and must be able to prepare test reports. Salary commensurate with experience. Contributory pension scheme and three weeks' annual holiday. Reply, stating age and experience.—BOX No. E3026, "The Engineer." A

ESTIMATOR required for production development department of company in S.W. Midlands engaged in light engineering. Experience in the compilation of cost estimates and an intimate knowledge of modern machine shop methods essential. Experience in estimating cost of tools and fixtures desirable.—Please give details of qualifications and experience and an indication of salary required to BOX IRA. 9988, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. E6441 A

EXPERIENCED ENGINEER'G DRAUGHTSMAN required for large papermill. Previous experience in papermaking machinery desirable. House available for suitable applicant. Write, giving usual particulars and salary required.—BOX No. E3024, "The Engineer." A

FIRST-CLASS WORKS MANAGER required for expanding structural and general engineering shops in S.W. Scotland. Applicants should have practical experience in welded and riveted construction. Substantial salary to suitable man.—Write, BOX E.989, c/o 191, Gresham House, E.C.2. E6400 A

GAS TURBINE DEPARTMENT of John Brown and Company (Clydebank), Limited, requires Designers and Draughtsmen for project and development work, which requires new ideas combined with practical experience.—Applications, stating age, qualifications, and previous experience, should be sent to Mr. Dick, Engine and Boiler Works, John Brown and Company (Clydebank), Limited, Clydebank. E6502 A

GENERAL DRAUGHTSMAN required, age 20–25, capable of working with minimum supervision and willing to take charge of design office as this is formed.—Apply, stating age, experience and salary required, to BOX No. 473, Erwoods, Limited, 211, Piccadilly, London, W.1. E6515 A

GENERAL WORKS MANAGER of company manufacturing in several countries requires P.A., preferably under 35, Graduate and Chemical or Mechanical Engineer ; must be suitable for promotion. Salary according to qualifications. Pension scheme. North London area.—BOX AC 86335, Samson Clarks, 57/61, Mortimer Street, London, W.1. E6498 A

HENRY WIGGIN & COMPANY, LIMITED, Wiggin Street, Birmingham, 16, manufacturers of nickel alloys, wish to increase the staff of their time and motion study department. Applicants must be really first-class work study engineers, having (a) a sound education, (b) not less than five years' experience of time and motion study work and the practical application of payment by results to production and maintenance service departments ; (c) a personality suitable for this type of work. The appointments offer wide scope and will be limited to keen and progressive men. A very good salary, commensurate with the experience and high standard required, will be paid. A non-contributory pension scheme is in operation.—Apply in writing to the Managing Director, giving full details of past experience and employers' education and qualifications. E6500 A

IMPERIAL CHEMICAL INDUSTRIES, LTD., Nobel Division, has a vacancy for a Metallurgist in their Research Department, Stevenston, Ayrshire. Candidates, who should be University Graduates, aged 28/32, and have had approximately five years' experience in metallurgical work, should be able to plan and carry out research programmes and investigations into plant failures. Experience in non-destructive testing (X-ray, gamma-ray, and ultrasonic), welding or corrosion, would be an asset.—Application should be made to the Staff Manager, 460, Sauchiehall Street, Glasgow, C.2. E6527 A

JIG AND TOOL DESIGN AND DETAIL DRAUGHTSMEN required for interesting work at Bath and Weston super Mare. Excellent salary, pension scheme available, good working conditions. Apply, giving full details of experience and qualifications.—BOX No. E6518, "The Engineer." A

JIG AND TOOL DRAUGHTSMEN wanted.—Apply, giving details of age, experience and qualifications, to Personnel Manager, Wadkin, Ltd., Green Lane Works, Leicester. E3007 A

JUNIOR CIVIL ENGINEERING ASSISTANTS required in Nyasaland office for work on roads, airfields and services. Three-year tour with passage, furnished accommodation and medical service provided. Salary commensurate with experience and qualifications.—Apply in writing to Scott and Wilson, 47, Victoria Street, London, S.W.1. E3027 A

JUNIOR TECHNICAL ESTIMATING ENGINEER required for pump manufacturers in London area.—Apply, Gwynnes Pumps, Ltd., 64, Chancellors Road, Hammersmith, W.6. E598 A

MAINTENANCE ENGINEER required by the Steel Company of Wales, Limited (Steel Division), Port Talbot, to take charge of repairs and rebuilding of open-hearth furnaces, soaking pits, and slab reheating furnaces, with a view to extending modern technique for fast repairs and the maintenance of high furnace availability. The plant consists of 144 coke ovens, 3 blast-furnaces (21ft. and 25ft. diameter), 20 open-hearth melting furnaces (100 and 200 tons), 20 soaking pits (100 tons), and 3 slab furnaces (105 tons/hour). Applicants should have particular knowledge of melting shop and mill furnace and good organising ability. Experience of furnace design and construction, choice of refractories, &c.—Those wishing to apply should write for official application form to the Personnel Superintendent, The Steel Company of Wales, Limited, P.O. BOX No. 3, Port Talbot, Glam. E6470 A

MANUFACTURERS OF PRECISION COMPONENT extensively used in steel works mechanical equipment, require Graduate Engineer, aged 25–35. Applicants must have experience of design, construction or operation of steel works machinery. The successful applicant will be given a thorough training in all aspects of the application of the company's product, so that he will be able to take responsibility for technical discussions with present and potential users. The appointment offers good prospects of promotion to executive position to a man with drive and personality. Pension scheme in operation.—BOX No. E6239, "The Engineer." A

MECHANICAL - ELECTRICAL ENGINEER, age about 35, required by old-established company manufacturing mining machinery, including electric winders. Capable of ultimately taking high executive position. Must have good knowledge of efficient production with a flair for general administration. Write, giving fullest details respecting education, experience, qualifications, age and salary required.—BOX No. E2990, "The Engineer." A

MECHANICAL ENGINEER required by London firm of civil engineering contractors for reorganisation and administration of the plant department. Applicants must possess sound technical knowledge and first-class practical experience and be able to plan the layout of the necessary repair shops. Apply, in confidence, giving full particulars of experience age and salary required.—BOX No. E3001, "The Engineer." A

MECHANICAL ENGINEER required, with normal basic electrical knowledge by old-established medium-size city engineering firm engaged in export and home trade. Wide range of products is handled, largely heavy industrial plant and machine tools. Requirements are (a) at least H.N.C., (b) keen on hard work, plenty of initiative and anxious to get on, (c) at ease meeting clients at the top or at shop floor level and capable of removing his coat to do emergency repair himself, (d) fair draughtsman, (e) good technical sales correspondent, (f) some knowledge of French helpful, (g) clean living, modest, loyal and completely trustworthy, manly type. Apply, own handwriting, with details age, education, experience, salary required, and applications failing to give these particulars fully will not be considered.—BOX No. E6471, "The Engineer." A

PETER BROTHERHOOD, LTD., Peterborough, require Draughtsmen (senior and junior), preferably with experience in design of compressors, turbines and steam engines. Permanent positions, five-day week, staff pension scheme. — Write, giving full details age, experience and salary required. E342 A

PRODUCTION ENGINEER required by Short Brothers and Harland, Limited, Belfast, to organise the batch manufacture of high-grade electronic equipment. Applicants must have had several years' production experience of radio or electronic apparatus and be able to provide liaison between development laboratories and factory. Knowledge of work study an advantage. Details re salary and housing facilities available on application.—Write, stating age and experience, to the Personnel Manager, Short Brothers and Harland, Limited, Queen's Island, Belfast. E6495 A

PRODUCTION ENGINEERS required by well-established firm in the West Midlands for planning and estimating. Applicants must have had wide experience in automotive mass production methods embodying latest technique. There are three vacancies for men with exceptional experience—one on assembly work, one on fabrication and press tools, and one on general machining. Good prospects, attractive salary, pension scheme and assistance with housing accommodation, where necessary, make these appointments of particular interest. Please write in strict confidence, setting out details of training and experience, with positions held in chronological order. The advertiser's staff have been notified.—BOX No. E3021, "The Engineer." A

For continuation of Small Advts., page 4

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The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18–64 inclusive or a woman aged 18–59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

PRODUCTION MANAGER required for precision engineering factory in County of Gloucester. Experience of tool design, production methods, stock control and workshop supervision essential. Pension scheme. State age, experience and salary required.—BOX No. E3031, "The Engineer." A

PRODUCTION SHOP MANAGER required by company engaged on rearmament contract. Applicants should have machine shop experience, be capable of setting up and operating precision machinery and of supervising skilled and unskilled labour. While the position offers immediate employment for 18 months to 2 years it may lead to a permanent appointment. An attractive salary and output bonus will be paid.—Apply in writing, giving details of age and experience, to the Personnel Officer, George Cohen, Sons and Co., Ltd., Stanningley, Nr. Leeds. E3020 A

PROJECT ENGINEER required to assist in cathodic protection schemes, including electrical surveys and preparation of schemes. Age 24–30 years. Candidates should have qualifications in electrical engineering with some mechanical engineering knowledge. Experience in plant erection and design work would be an advantage. Training in the work will be given. Post is tenable in London, but will involve a certain amount of travel in this country.—Apply, Staff Dept., The Distillers Co., Ltd., 21, St. James's Square, London, S.W.1. E6494 A

QUALIFIED ENGINEER, excellent prospects for right man wishing to make career with iron ore mining company, West Africa. Must be Associate Member, Inst.C.E. or equivalents, and been in responsible charge important work. Some knowledge mechanical and electrical engineering essential, with University Engineering Degree desirable ; age 30 to 40. Annual salary £1500 or according to qualifications and experience. Contract two tours, 12/18 months each. Liberal leave on full salary ; free furnished quarters, medical attention and travel ; pension scheme.—Write, giving full details of qualifications and experience, with copies of references, age, married or single, to Sierra Leone Development Co., Ltd., City-Gate House, Finsbury Square, London, E.C.2. E6522 A

REPRESENTATIVE for Yorkshire required by firm of mechanical handling engineers. Must (a) be a qualified engineer ; (b) be able to prepare complete mechanical handling layouts ; (c) be able to oversee site erection ; and (d) have knowledge of E.O.T. cranes, conveyors, elevators and foundry work. Past experience as designer and estimator desirable. Apply, stating age and salary required.—BOX No. E3029, "The Engineer." A

REPRESENTATIVES on commission basis, calling on engineering merchants, required by manufacturers of new type of adjustable leather V-belt (patented).—BOX No. E3023, "The Engineer." A

ROWNTREE & CO., LTD., the Cocoa Works, York, require a Designer-Draughtsman. Technical and shop training essential on the manufacture of medium-size automatic machinery. Applicants must be capable of accepting full responsibility for design and detail drawings. Higher National Certificate standard preferred.—Write, stating age, qualifications, experience and salary required, to Staff Officer (Men). E6426 A

SALES ENGINEER, aged early 30's, with good experience both mechanical and electrical, required by British company in Addis Ababa, Ethiopia, to take charge of agencies held by autos. and engineering departments. Apart from personality and ability to effect sales in the territory, successful candidate will be responsible for staff, stocks and organisation of his departments. Good prospects to keen man. Free air passages, annual bonus, home leave and pension schemes.—Write, BOX "DE/73," c/o 95, Bishopsgate, E.C.2. E6512 A

SALES ENGINEER for repetition sheet metal and large-size power press work required by Midlands manufacturer. Excellent opportunity for gentleman with right experience and connection. Salary, adequate expenses and commission.—Applications, which will be treated in strict confidence, to James, Stanley and Co., Accountants, 46, Cherry Street, Birmingham, 2. E6526 A

SALES EXPORT MANAGER wanted for Henry Meadows to develop and take charge new export sales programme. Excellent prospects ambitious progressive man as member of reorganised management team under stimulating leadership. Desirable age range strictly 32–45. Previous overseas sales experience necessary. Facility with foreign languages highly desirable. Must be good planner, preferably with market research experience. Essential to meet high standards executive qualifications and potential. Successful candidate must be willing to travel anywhere, have good appearance and manner, and be adaptable with imagination and drive. Knowledge of diesels particularly marine applications, essential. Apprenticeship and A.M.I. Mech.E. or equivalent required. Headquarters in or near Wolverhampton. Basic salary in line with responsibilities involved. — Apply, in guaranteed confidence, stating details, age, education, experience, with names of firms, positions, salaries and telephone number, to :

P. S. CABOT AND COMPANY,
59, New Cavendish Street,
London, W.1. E6458 A

SENIOR DRAUGHTSMEN required in Manchester, 25 years of age and upwards, experienced in the design and detail of mechanical handling plant and structural steelwork. General engineering training to H.N.C. standard preferred. Good salary. Production bonus in operation.—Apply to "E" Department, West's Gas Improvement Co., Ltd., Albion Ironworks, Miles Platting, Manchester, 10. E138 A

SENIOR DRAUGHTSMEN required, with experience of power transformers. Experience on on-load voltage regulators an advantage. Good salary, contributory pension scheme.—Apply, stating age, experience and salary required, to Brentford Transformers, Limited, Kidbrooke Park Road, London, S.E.3. E2991 A

SENIOR DRAUGHTSMEN required, preferably experienced in firebrick work, structural or heavy machine work for industrial furnace equipment for the steel, glass and non-ferrous industries. Permanent progressive positions for keen men ; five-day week, pension scheme.—Apply in confidence, stating particulars and salary required, to Personnel Manager, Stein and Atkinson, Ltd., Parnell House, 25, Wilton Road, London, S.W.1. E6432 A

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SENIOR MECHANICAL DRAUGHTSMAN required for permanent post in Shropshire. Knowledge of crane work an advantage.—State age, experience and salary required.—Apply in first instance to Adamson-Alliance Co., Ltd., 165, Fenchurch Street, London, E.C.3. E3022 A

SENIOR PLANNING AND LAYOUT ENGINEER for large engineering company in the Midlands. Must have had long experience in the mass production of the assembly, painting and trimming of motor-car bodies. Apply, giving full details, age and experience and salary required, to Personnel Manager.—BOX No. E6459, "The Engineer." A

SENIOR RESIDENT ENGINEER (£1900 plus cost-of-living allowance), ASSISTANT RESIDENT ENGINEER (£1000 by £50 to £1200 plus cost-of-living allowance) are required on the construction of water supplies to a number of towns in the Sudan. Candidates should hold civil engineering qualifications and experience in electrical and mechanical engineering would be an advantage.—Appointments will be made under contract to the Consulting Engineers, Howard Humphreys and Sons, 191, Victoria Street, S.W.1, from whom full details and application forms may be obtained. E3015 A

SENIOR SITE CONSTRUCTION ENGINEER required by important firm of consulting and contracting engineers for petroleum and chemical plant. Experience in erection of process plant and equipment essential. Applications, giving full details of career should be addressed.—BOX No. E611, "The Engineer." A

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STRUCTURAL DRAUGHTSMAN required. Should have experience in reinforced concrete, knowledge of prestressed concrete and foundation work an advantage. Salary range £400–£700. Apply in writing, with full details of qualifications and experience.—BOX No. E2999, "The Engineer." A

STRUCTURAL ENGINEERING DESIGNER required. Must be experienced and capable of designing reinforced and prestressed concrete. Experience of foundation work an advantage. Salary range £600–£900. Apply in writing, with full details of qualifications and experience.—BOX No. E2998, "The Engineer." A

STRUCTURAL STEEL INSPECTORS OF WORKS required by consulting engineers on power station construction near Bristol and Southampton.—Write, stating age and experience, to Sir William Halcrow and Partners, MM.I.C.E., 47, Park Lane, London, W.1. E6513 A

STRUCTURAL STEELWORK Detail Draughtsman required in Manchester. Good salary ; production bonus in operation.—Apply to "E" Department, West's Gas Improvement Co., Ltd., Albion Ironworks, Miles Platting, Manchester, 10. E147 A

TECHNICAL ENGINEERS.—Several Engineers are required by a well-known firm of engineers in the North Midlands. The applicants should be fully experienced in one or more of the following :—

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TIME STUDY ENGINEER is required by progressive company in S.W. Lancs, to undertake work study investigations in chemical processes and plant maintenance. Engineering qualifications and/or several years' experience as a time study engineer in a chemical or engineering factory are essential. The position is permanent and covered by a superannuation scheme. Applications, which will be treated in confidence, should contain full relevant details.—BOX No. E6427, "The Engineer." A

TEST ENGINEERS required by large electrical and mechanical engineering firm in S.E. London area. Successful candidates will be required to work on the analysis of test results, investigation and diagnosis of faults on hydraulic and electro-mechanical precision mechanisms. At least 3 years' experience of this type of work in either industrial or Government establishments is essential, together with engineering degree or equivalent technical qualifications.—Write, fully stating age, experience and salary required, to Box E.117, c/o 191, Gresham House, E.C.2. E6503 A

THE BRUSH ELECTRICAL ENGINEERING CO., LTD., is seeking Candidates for responsible posts in its switchgear division. Applicants should be approximately 30/35 years of age and whilst Higher National Certificate plus a good apprenticeship will be acceptable, preference will be given to men with an Honours Degree in Engineering. Candidates should have sound experience of one or more of the following functions ; switchgear design, production or sales. A good commencing salary will be paid and there are prospects of promotion to senior management posts. —Please apply to the Chief Personnel Officer, The Brush Electrical Engineering Co., Ltd., Loughborough, Leics. E6501 A

THE ENGLISH ELECTRIC CO., LTD., Stafford, have vacancies for Draughtsmen to work on a wide variety of heavy electrical machines, including the largest water and steam-driven alternators and mill motors. These are interesting positions offering prospects of advancement.—Write, quoting Ref. 74D, to Dept. C.P.S., 336/7, Strand, W.C.2. E6328 A

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THE PROPRIETOR of British Patents Nos. 540,158, 526,776 and 526,782, entitled "Improvements in Rotary Pumps or Motors," "Improvements in or relating to Pumping Systems," and "Improvements in or relating to Rotary Radial Hydraulic Pump or Motors," offer same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, East Jackson Boulevard, Chicago, 4, Illinois, U.S.A. E6492 H

THE PROPRIETOR of British Patents Nos. 540,207, 540,166 and 540,242, entitled "Improvements in or relating to Hydraulic Machinery," "Improvements in or relating to Hydraulic Machinery" and "Improved Valve for Hydraulic Circuits," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, East Jackson Boulevard, Chicago, 4, Illinois, U.S.A. E6493 H

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THE PROPRIETORS of British Patent No. 645,593 for "Cylinder Construction for Parallel Cylinder Pumps," desire to enter into negotiations with a firm or firms for the Sale of the Patent or for the grant of Licences thereunder.—Further particulars may be obtained from Marks and Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E6481 H

THE PROPRIETORS of British Patent No. 645,494 for "Improvements in or Relating to Mowing and Like Machinery," desire to enter into negotiations with a firm or firms for the Sale of the Patent, or for the grant of Licences thereunder.—Further particulars may be obtained from Marks and Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E6480 H

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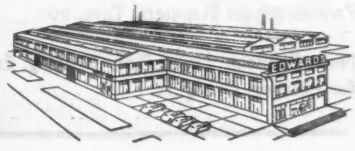

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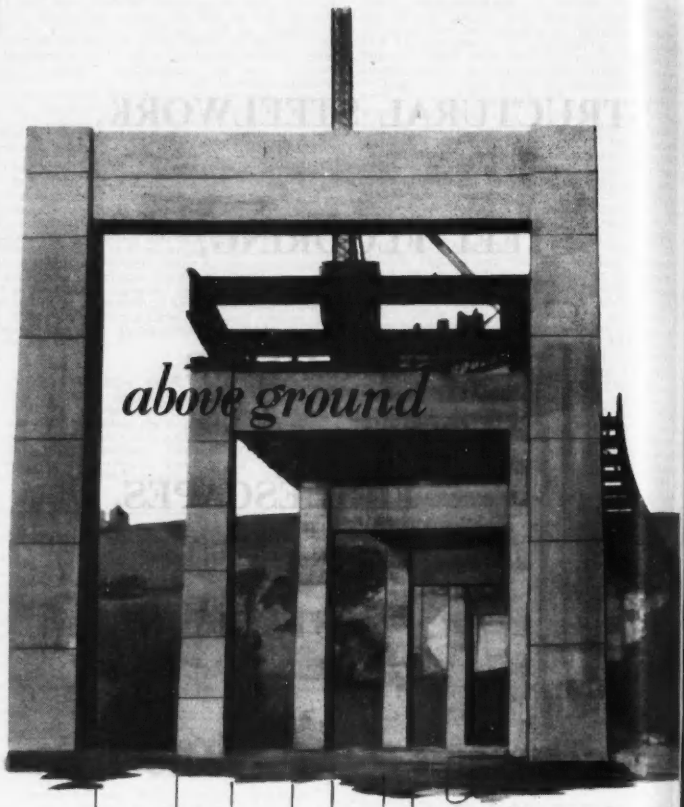

and below Cleveland's engineers are building structures which are designed to withstand the passage of time. Deep foundation work is a Cleveland speciality and is an integral part of the modern science of heavy structural engineering. To whatever depth or to whatever height – in any part of the world – Cleveland engineering means enduring strength.

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PATENT CUTTER HOPPER DREDGERS, PATENT DIPPER DREDGERS, BUCKET DREDGERS, GOLD & TIN RECOVERY DREDGERS, FLOATING CRANES.

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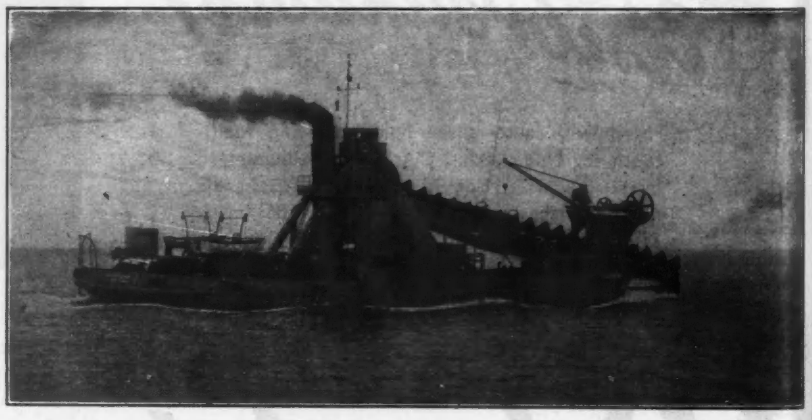

Twin Screw Bow Well Bucket Dredger "Abertawe" constructed for the Great Western Railway Company. Dimensions: 160ft. × 40ft. × 14ft. Speed: 8½ knots. Buckets: 27 cub. ft. Specified Dredging Output: 900 tons per hour.

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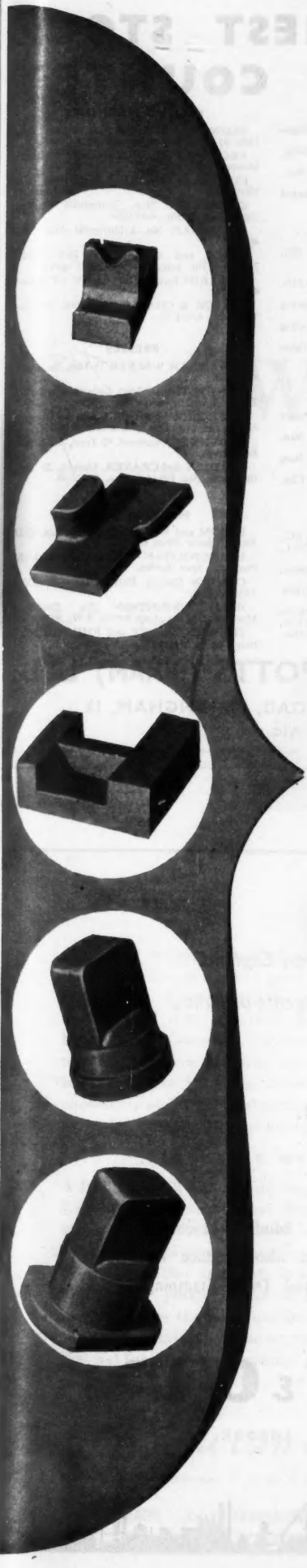
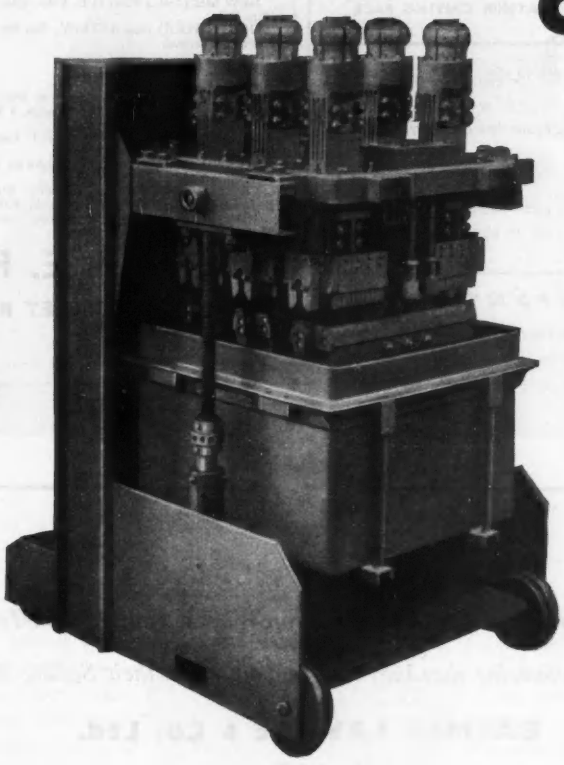


CASTINGS in high conductivity copper



STONE's castings have always held an important place in every phase of engineering development. The oil circuit breaker illustrated (manufactured by the Brush Electrical Engineering Company Ltd.) incorporates high conductivity copper castings—97% I.A.C.S., and provides a typical example of the many uses for the high quality products of our foundries. Every stage of production is quality-controlled; radiological examination is used to detect faults before machining.

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The photograph of the 3,000 amp, 440 volt oil circuit breaker, of breaking capacity 30 mVA, is reproduced by courtesy of the Brush Electrical Engineering Company Ltd.

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Illustration shows a Miraclo Belt on a 5 h.p. coin press. Ratio 16½:1, 91° arc of contact.

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PETERMAN 7mm, Single Spindle, High-Speed, 10,000 r.p.m. Max., motorised.
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B.S.A. 4 Spindle, 2¼in. cap., 9 speeds, arranged for motor drive.

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METROPOLITAN - VICKERS 390 kVA., Projection Spot Welder.
COBORN Electric Butt Welder, 48 kVA., 230/440/3/50.
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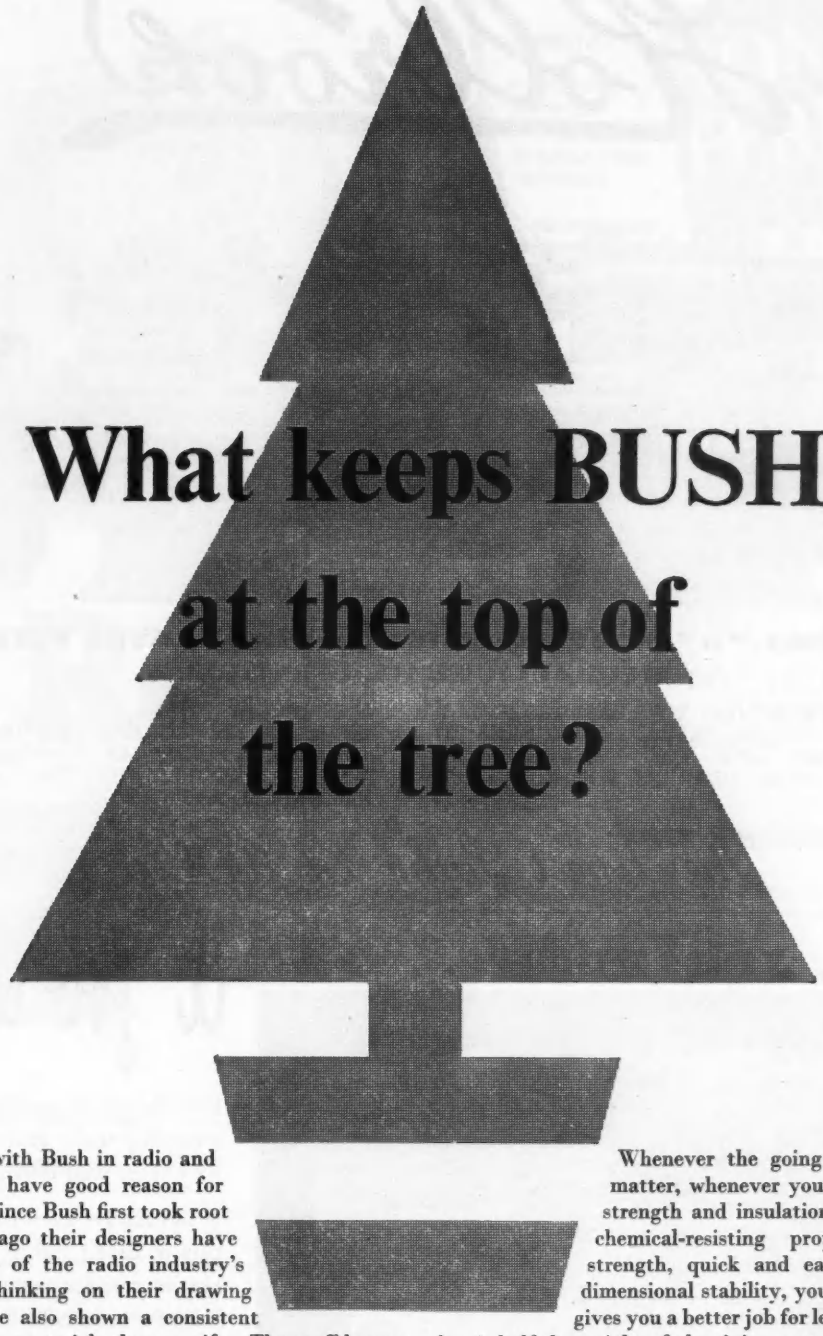

SO MANY end up with Bush in radio and television—and have good reason for their choice. Ever since Bush first took root over twenty years ago their designers have been putting some of the radio industry's most progressive thinking on their drawing boards. They have also shown a consistent choosiness about the materials they specify. The stuff has to be pretty good to be good enough for Bush.

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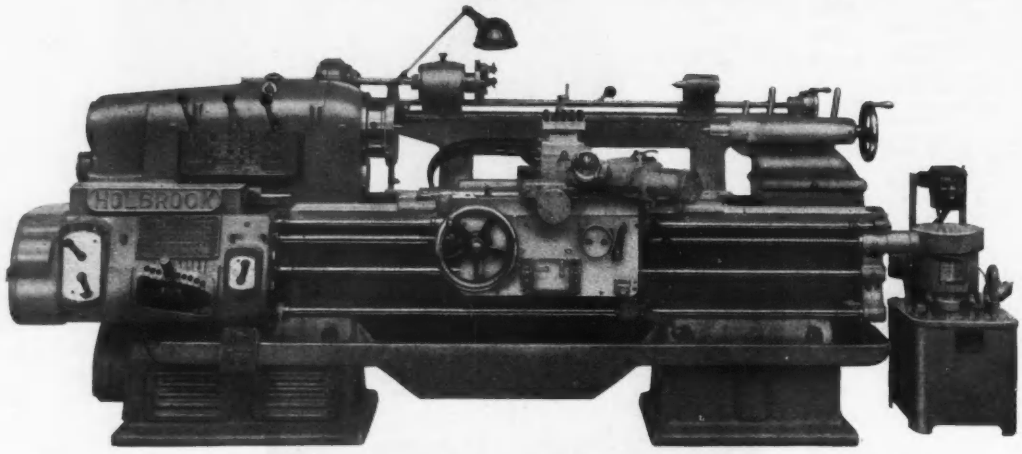

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THIS EQUIPMENT HAS TWO HYDRAULICALLY OPERATED SLIDES, ONE AT 90 DEGREES TO THE CENTRE LINE FOR FORM TURNING AND ONE AT 45 DEGREES FOR SHOULDER WORK.

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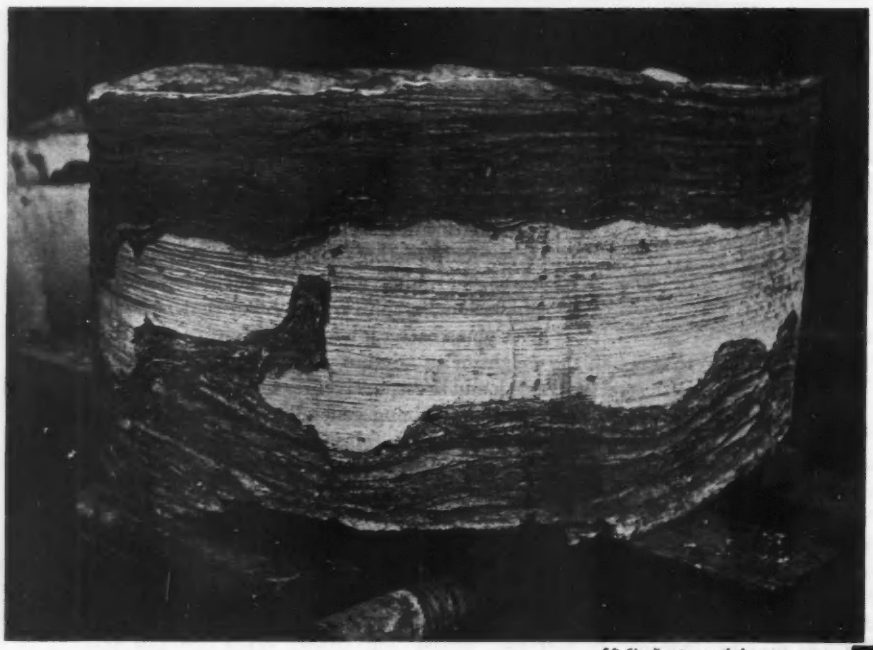

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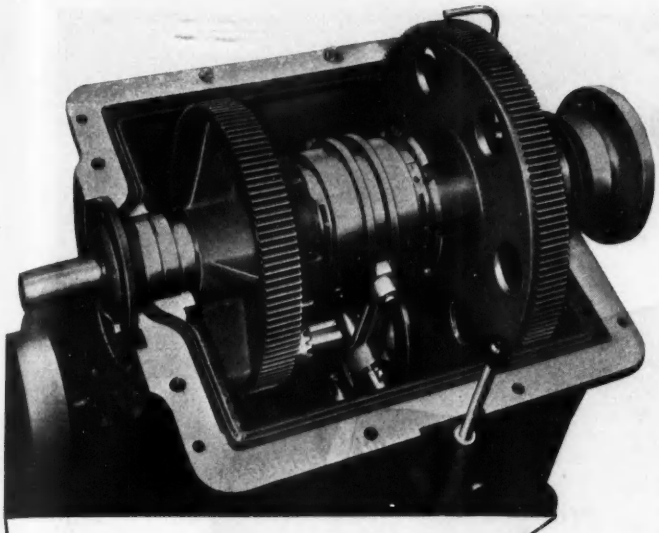

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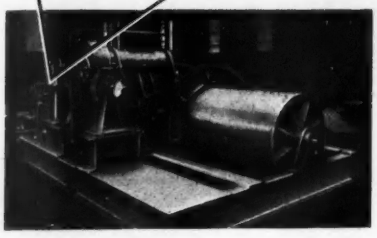

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* *Top illustration shows an internal view of the specially designed 2-speed Spur Reduction Gear Unit.*

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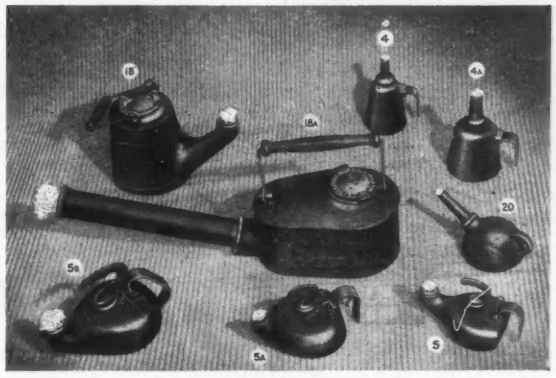

The Paraffin Burning Lamps illustrated are suitable for all industrial users including Engineering Works, Foundries, Shipyards, Ships, Power Houses, Bakeries, Gas, Electricity, Water and Transport Departments.

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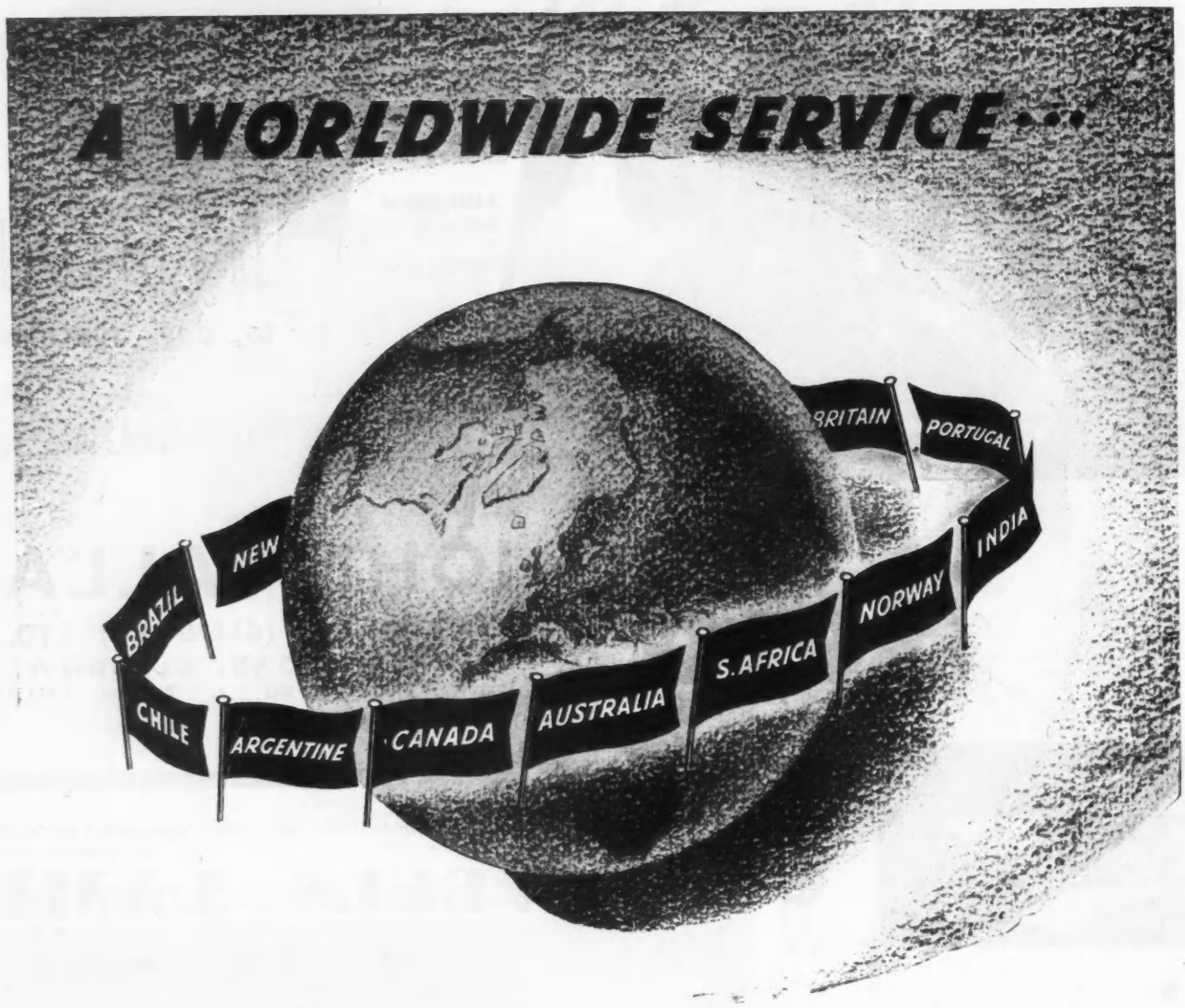

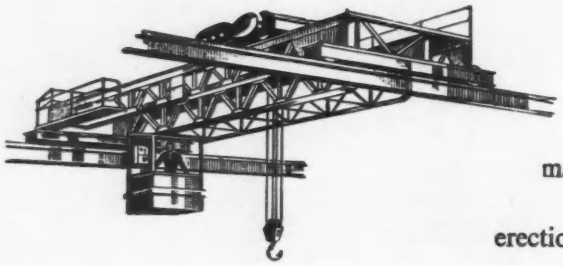

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Cooling fins cast integral on the underside of the case.
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Rugged design of gear case.

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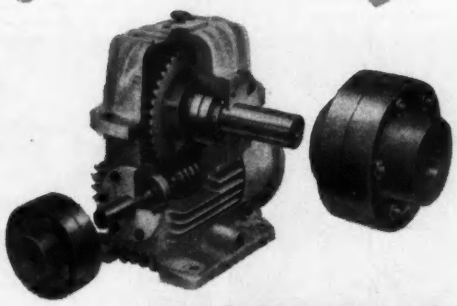

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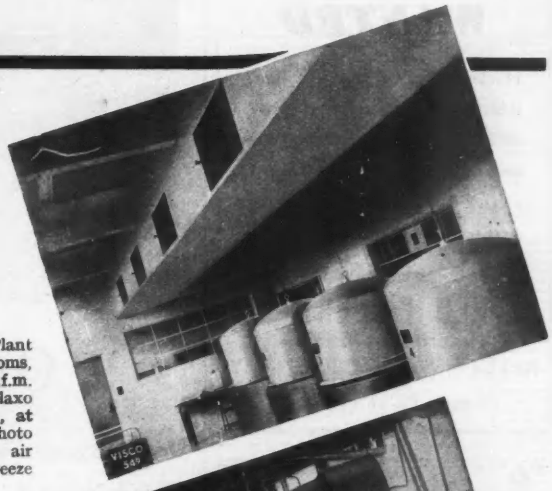
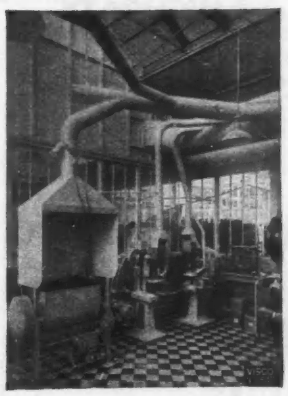


Air-Conditioning Plant for Sterile Rooms, capacity 8,500 c.f.m. (supplied to Glaxo Laboratories Ltd., at Ulverston). Photo shows high level air supply duct in Freeze Drying Room.

"Visco" Air Conditioning Plant for Sterile Rooms, capacity 8,500 c.f.m., showing supply and re-circulation fans, brine cooler, viscous filters and air heater. Photo: Courtesy of Glaxo Laboratories Ltd., Ulverston.

VEC



"Visco" Heating and Ventilating Plant supplied to Messrs. May & Baker Ltd. Photo shows view of dust remover hoods on powder mixer and tabletting machines.

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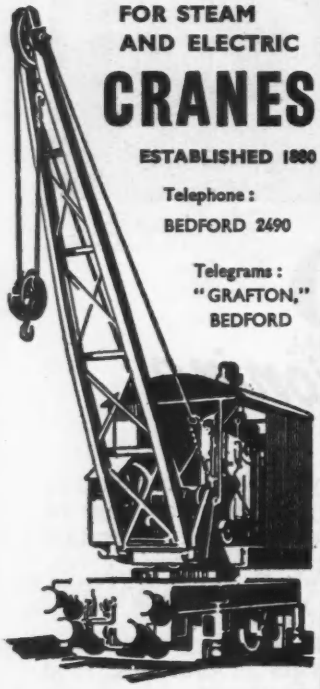

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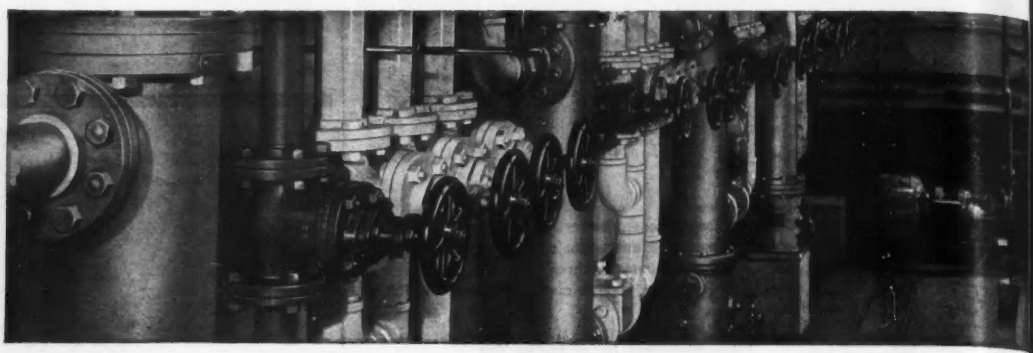
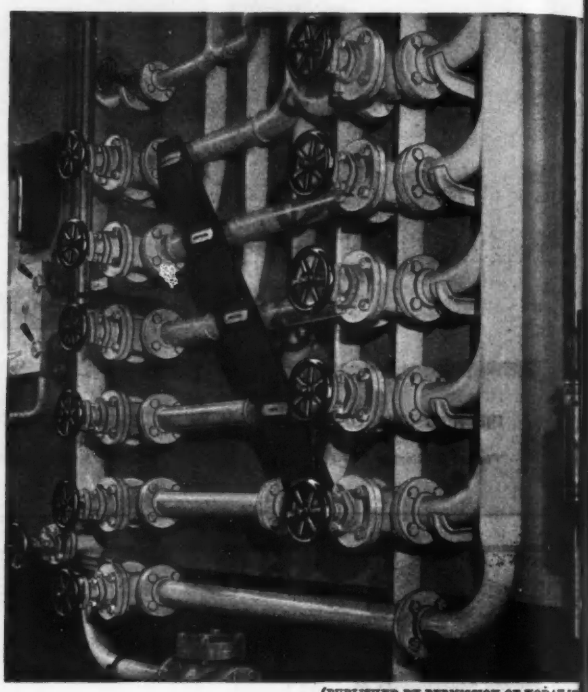


Once again, valves by Crane...

For well over a decade the original Crane valves installed in the Harrow factory of Kodak Ltd. have been giving efficient, trouble-free service. Performances like this, in works all over the country, have given Crane its great reputation for absolutely reliable valves. This reputation is based on Crane's high standards of design and manufacture — raw materials chosen to rigid specifications, precision methods of production, exacting tests of finished valves. Manufacturers and engineers, who base their judgment on results, specify Crane for the finest in valves.



The illustrations show the Crane valves installed in the Main Compressor House of the Kodak Harrow factory

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CRANE VALVES OF GUN METAL, CAST IRON AND CAST STEEL

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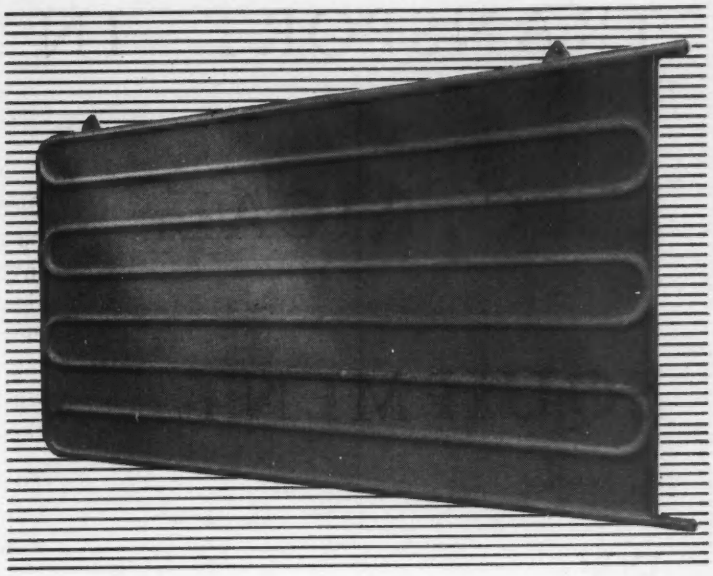

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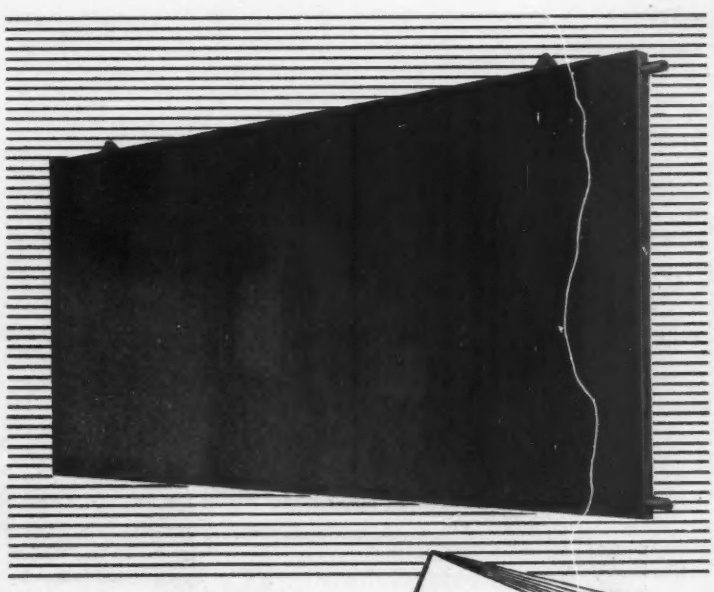

Amongst their many special advantages, here are three that merit the attention of Heating Engineers, Architects, Works Managers etc.:-

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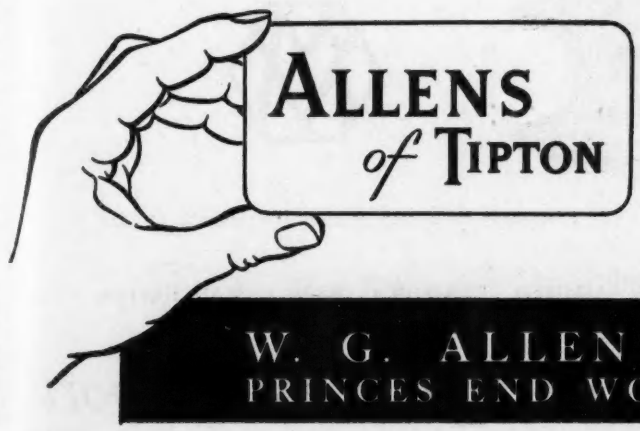
- **Panels may be grouped to give "warm spots" or "cool spots" as may be required.**
- **Full radiation is received by personnel as soon as heat is turned on, greatly reducing "warming-up" time.**



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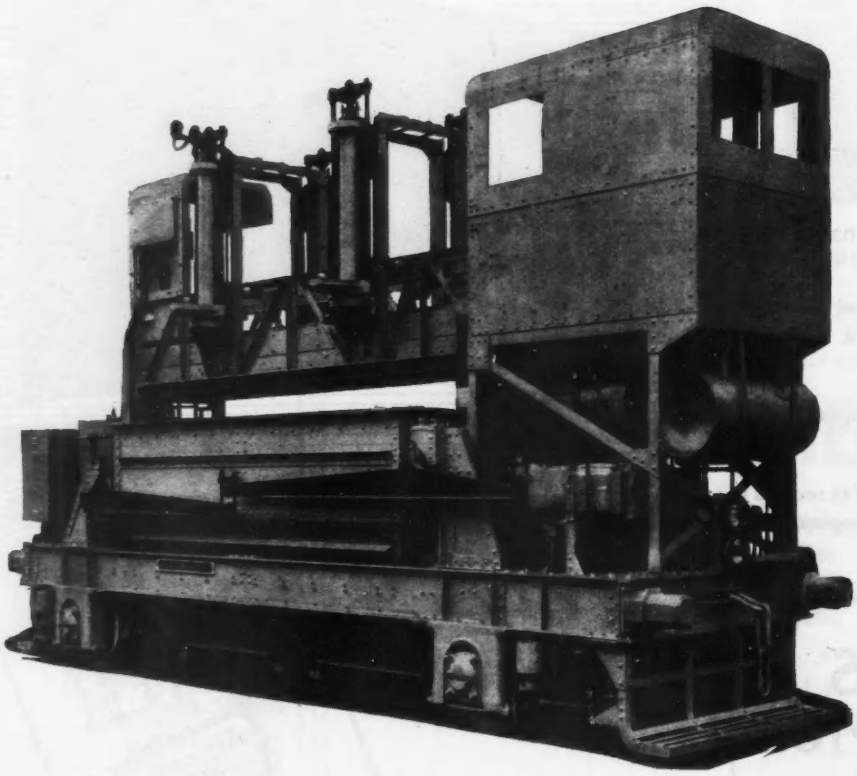

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Photograph by courtesy of Head Wrightson & Co. Ltd.

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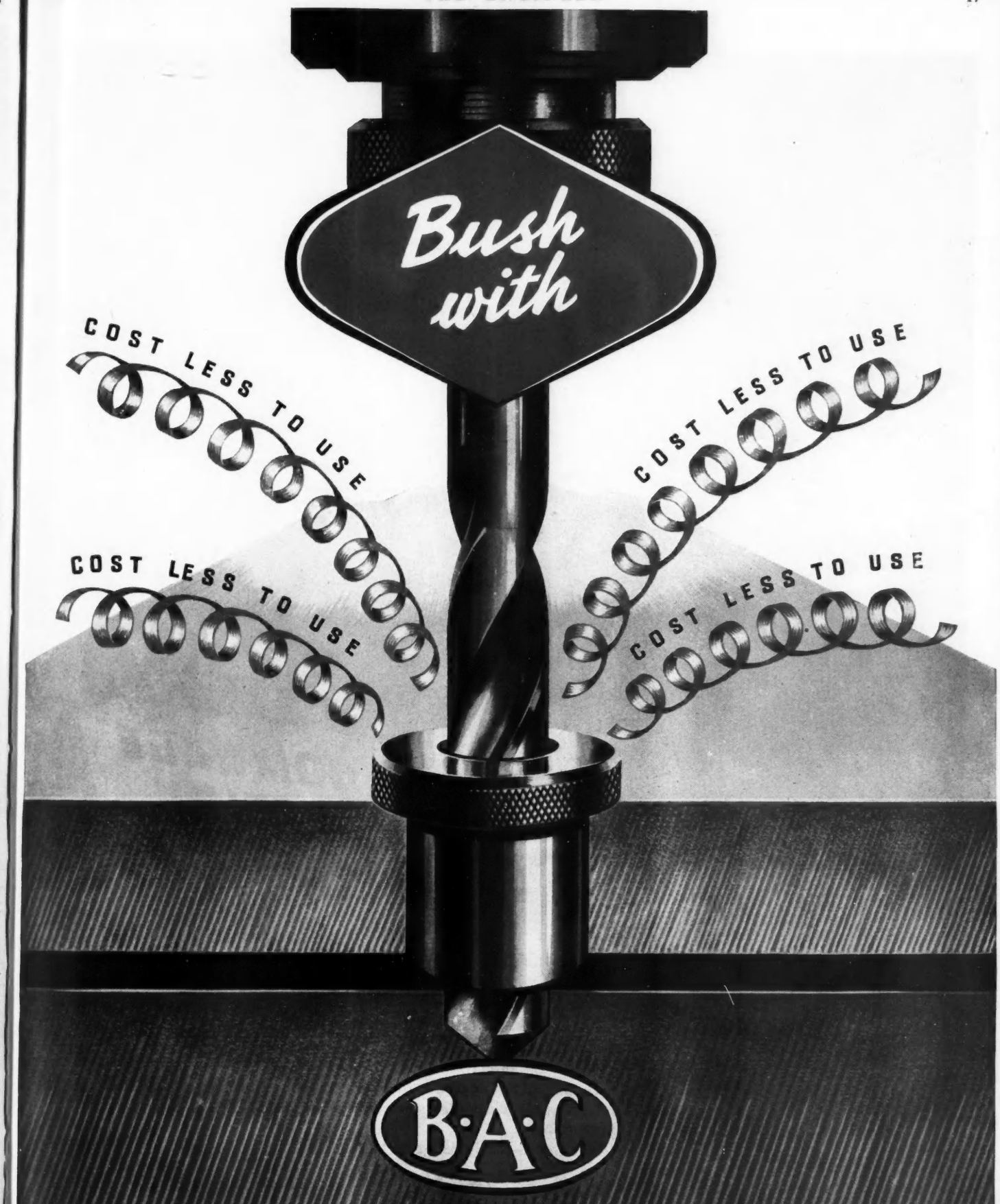

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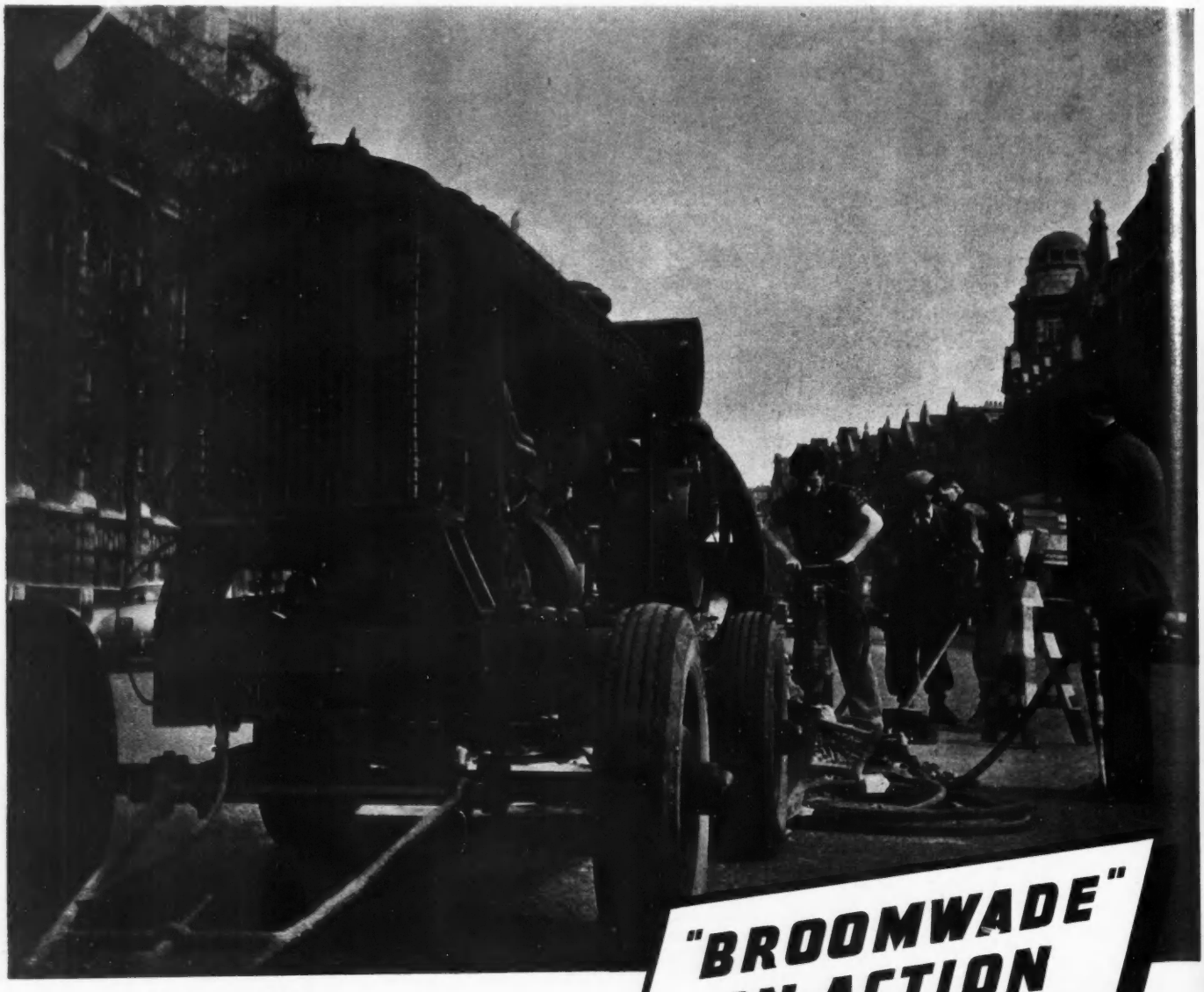

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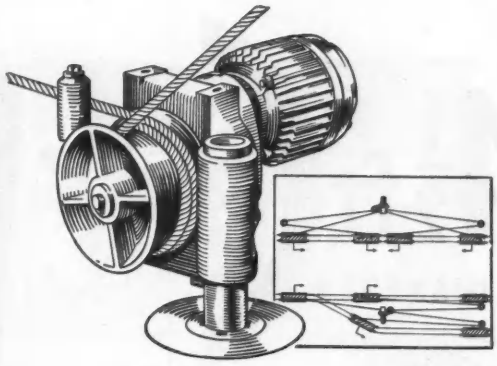
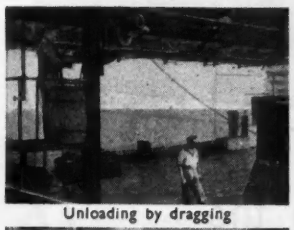


Close up of Capstan and General Layout.



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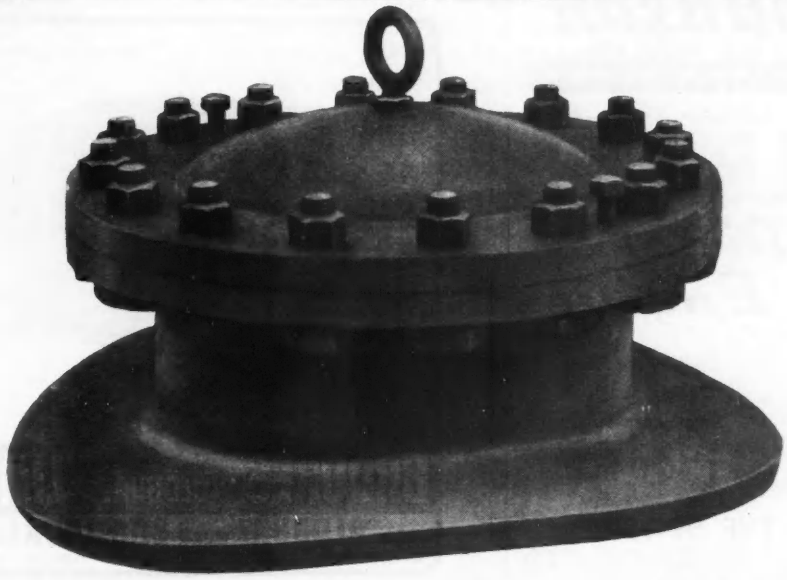

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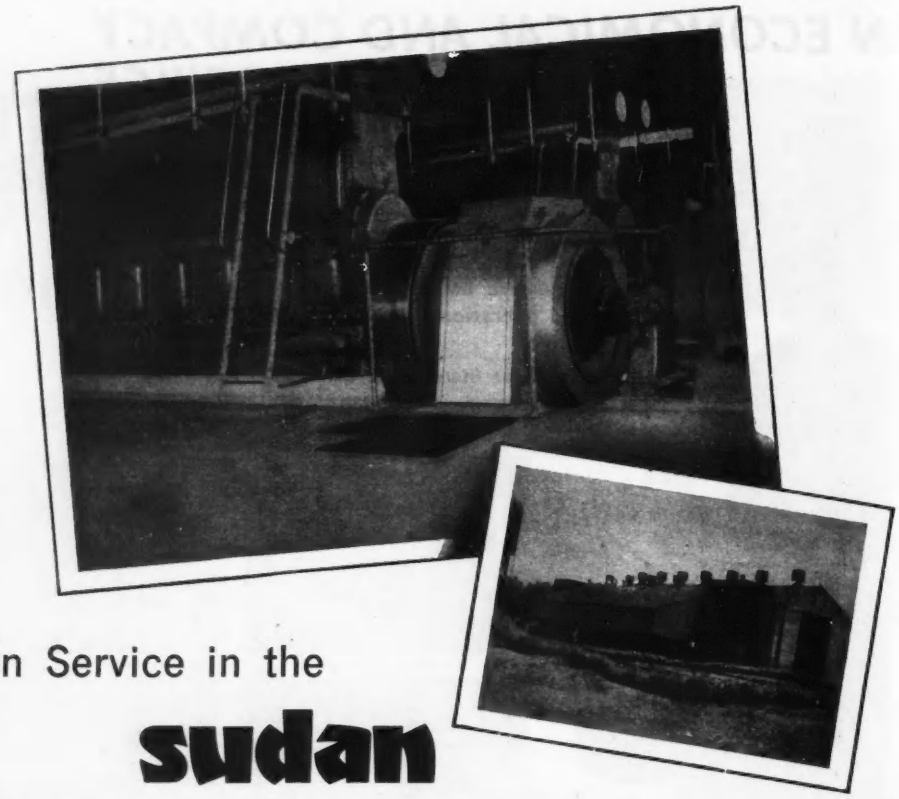

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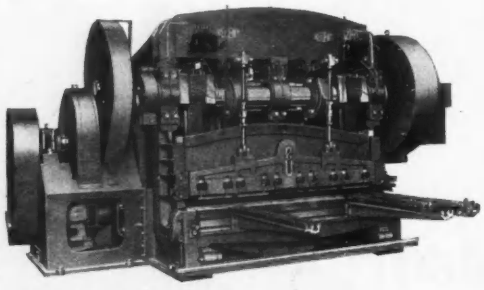

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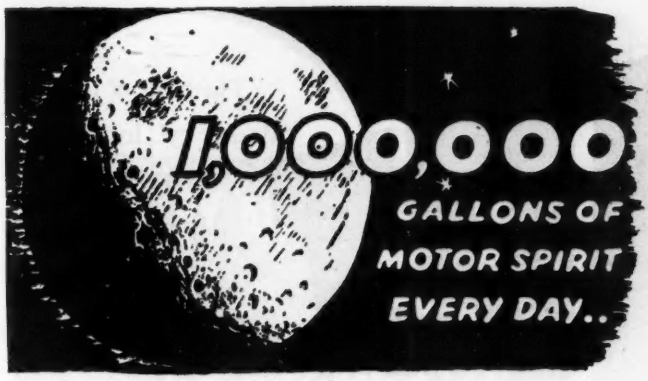

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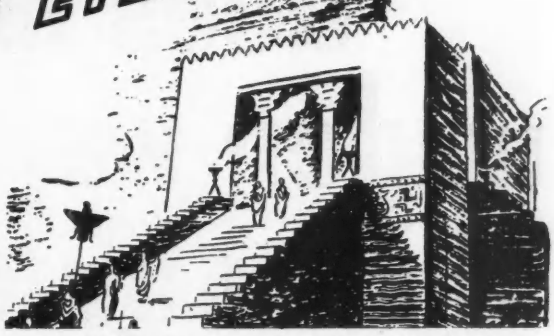

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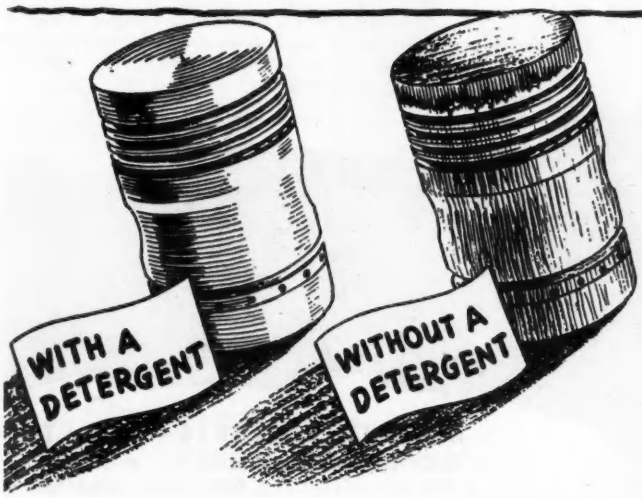

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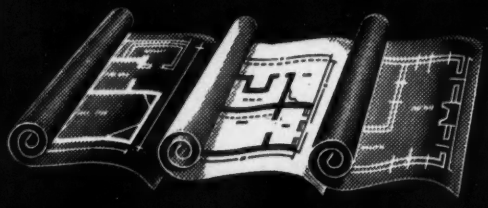

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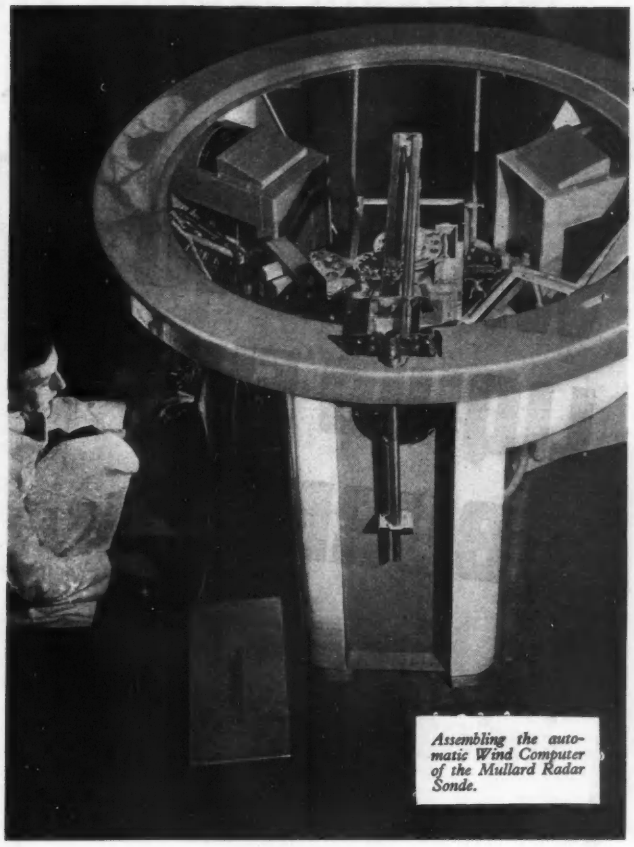

Assembling the automatic Wind Computer of the Mullard Radar Sonde.

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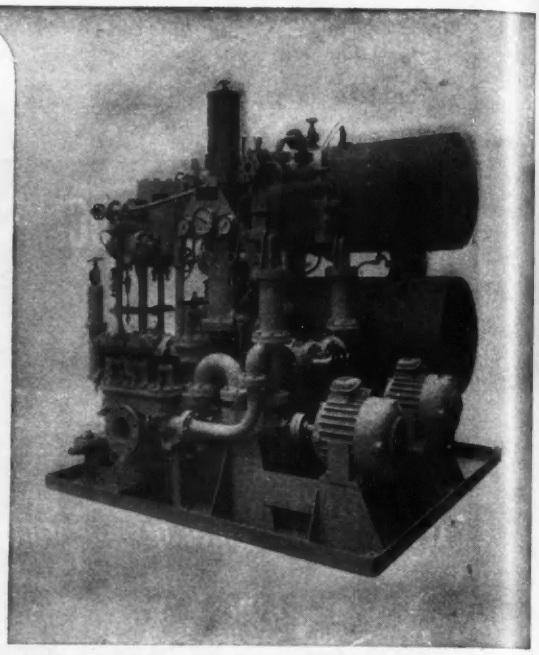

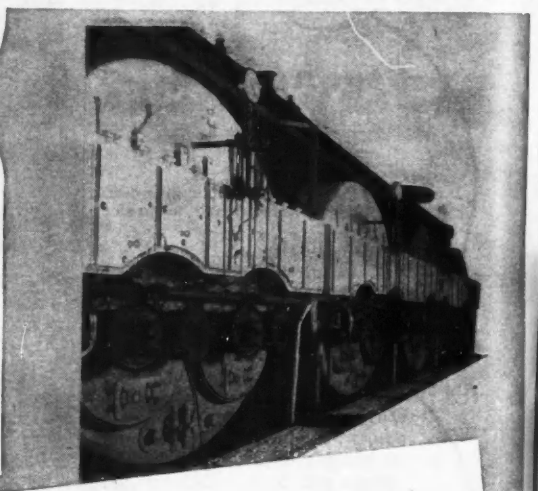

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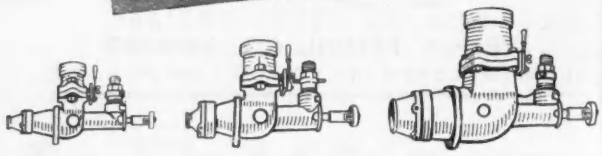

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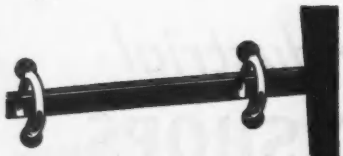

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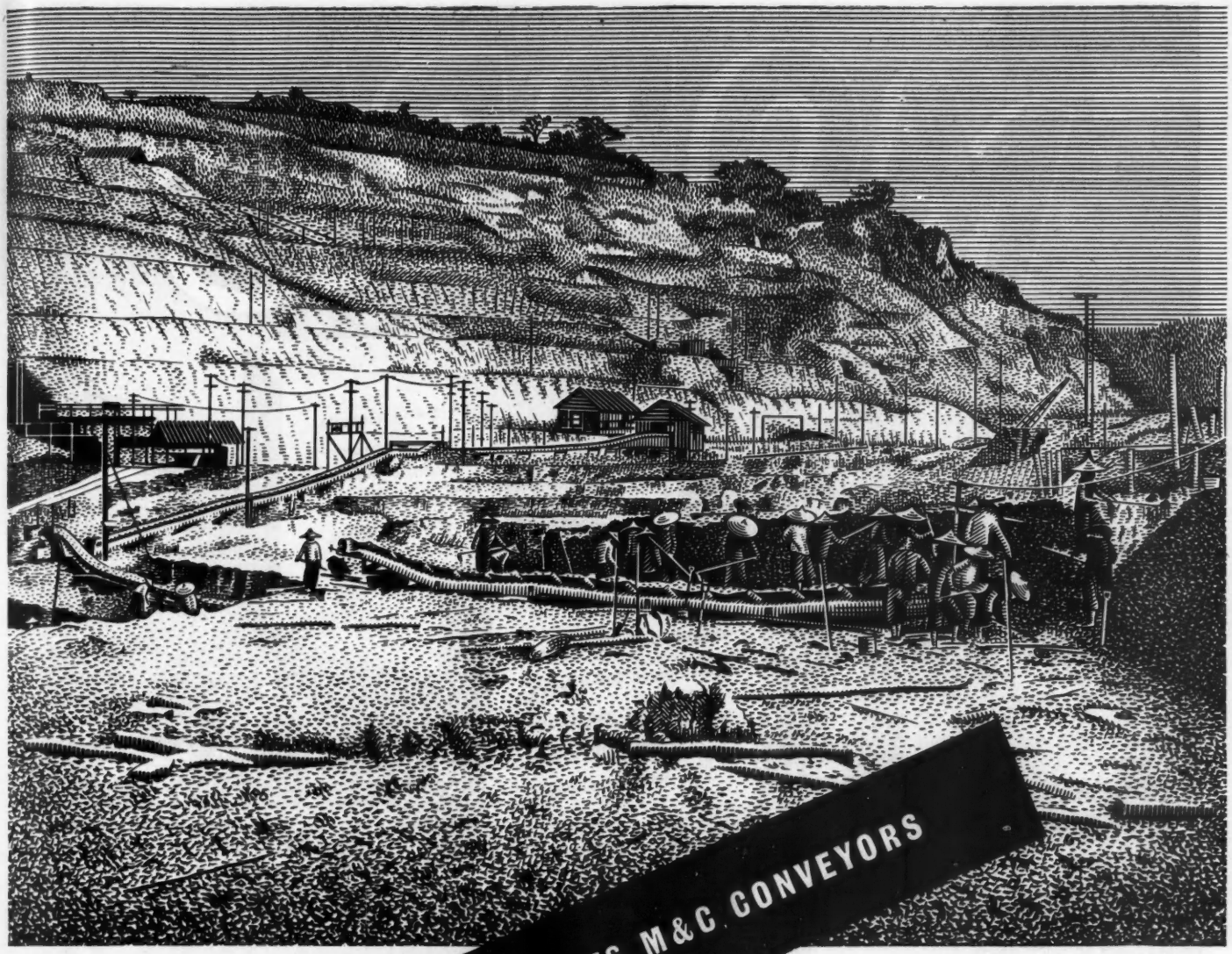

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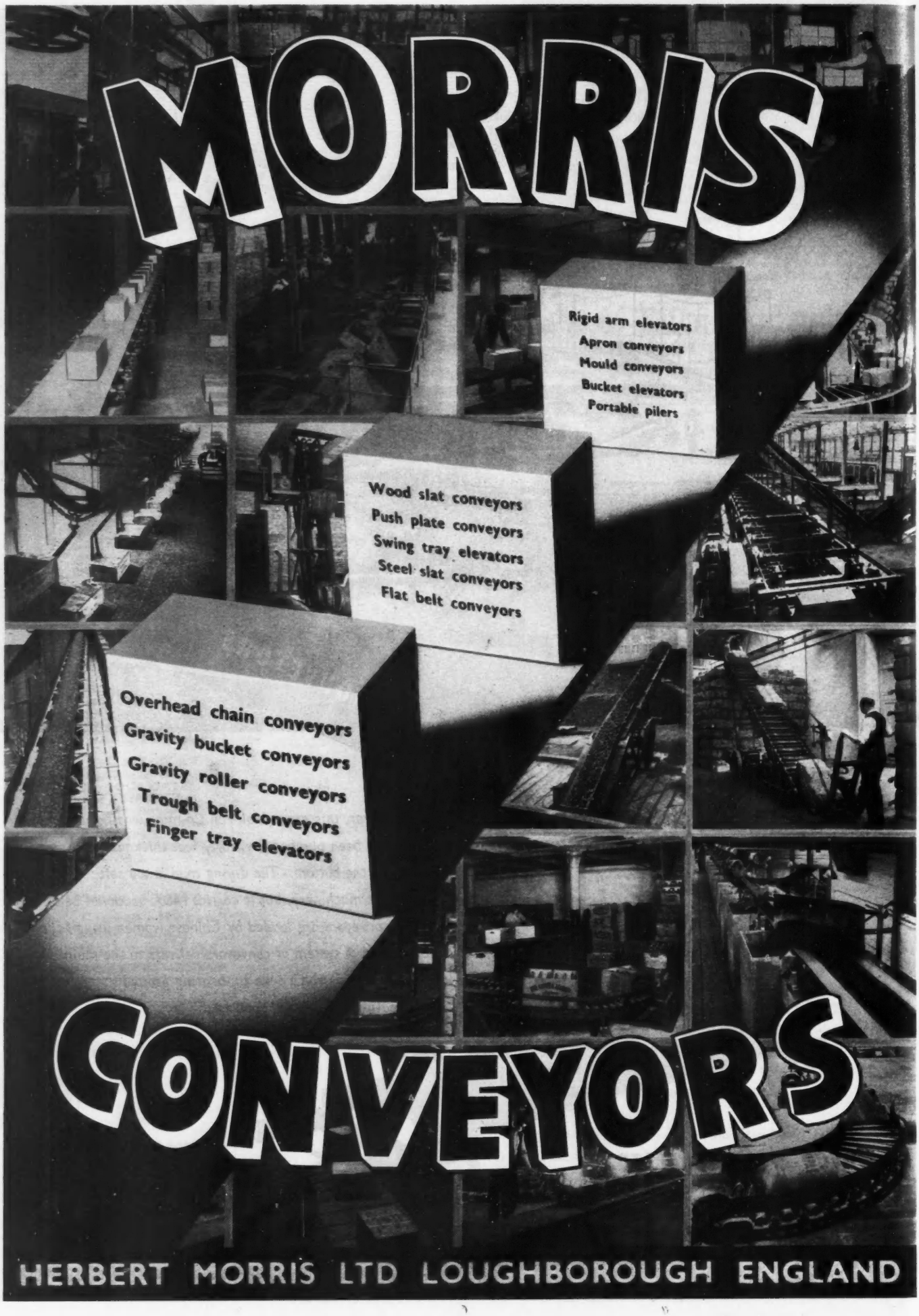
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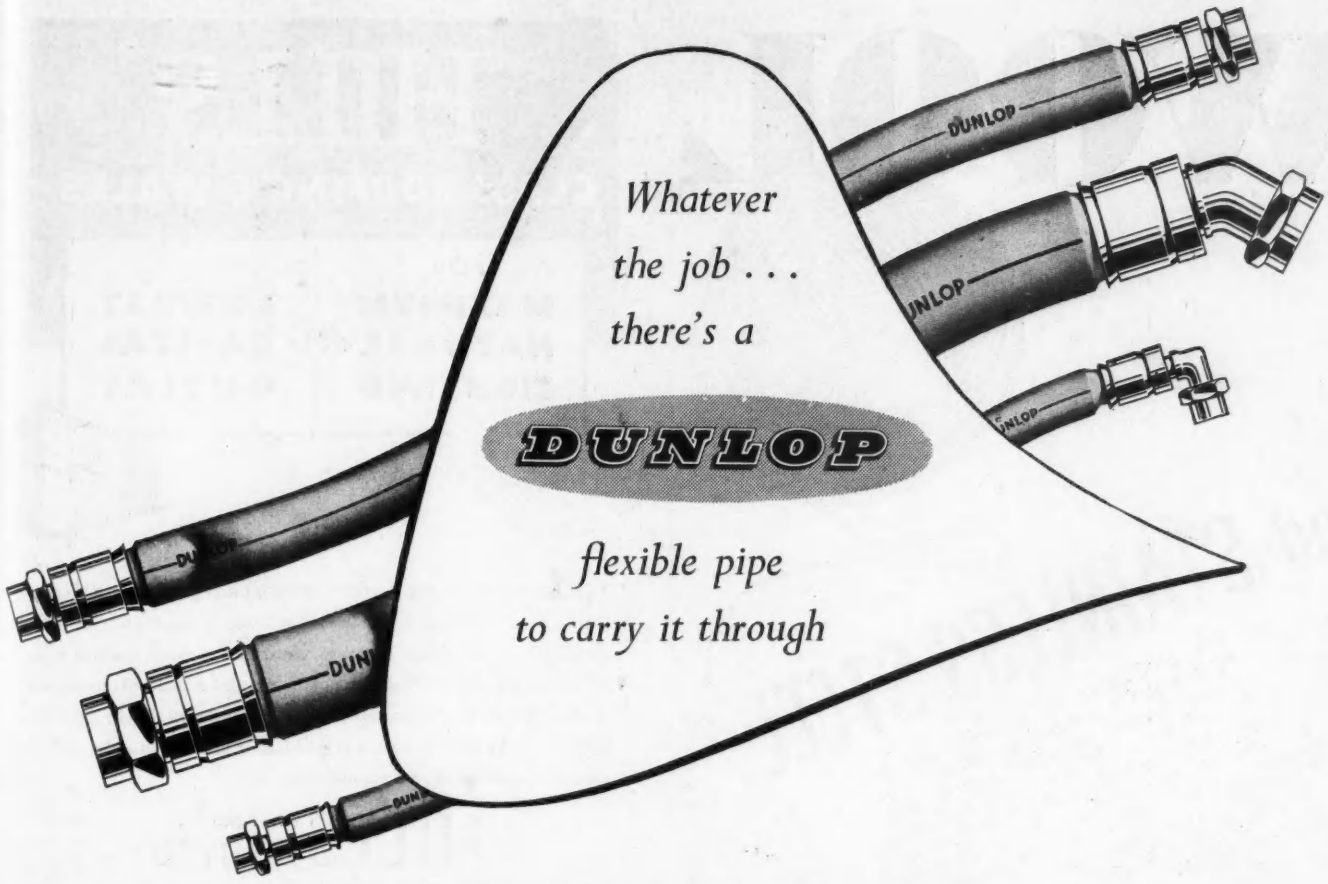
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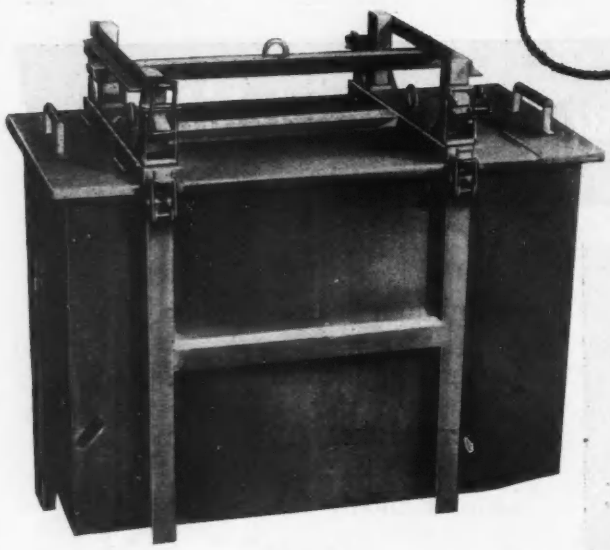

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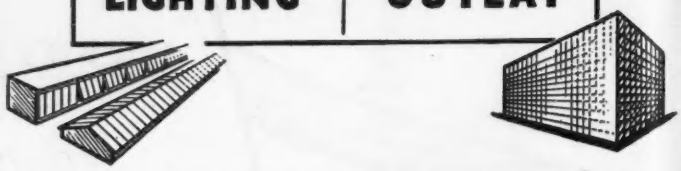

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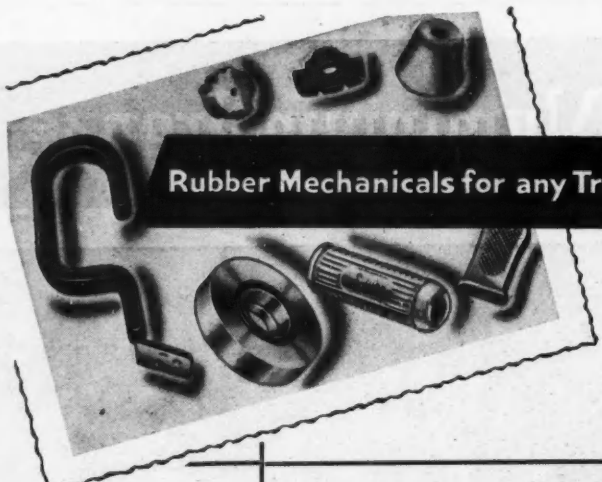

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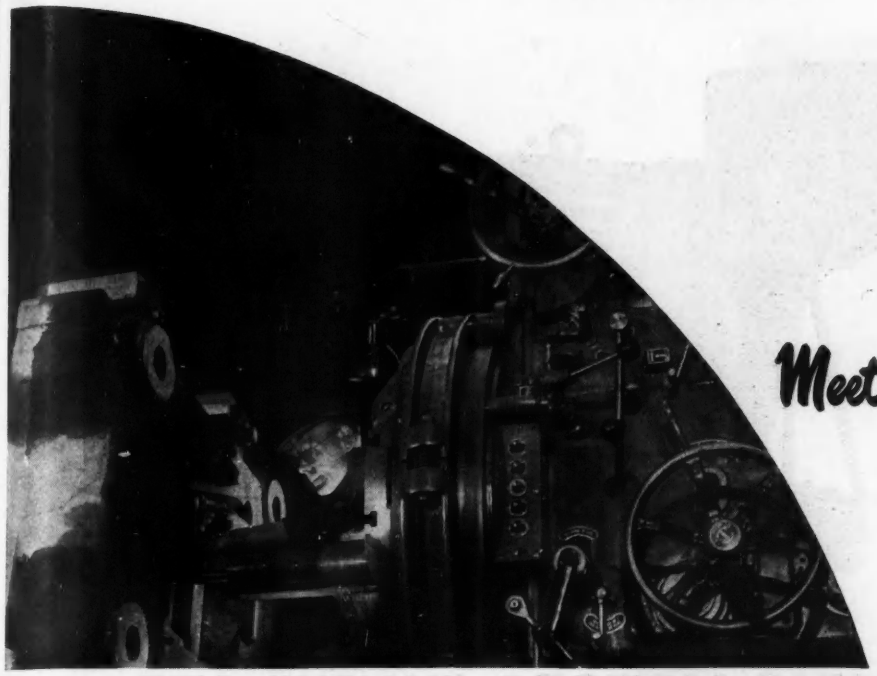

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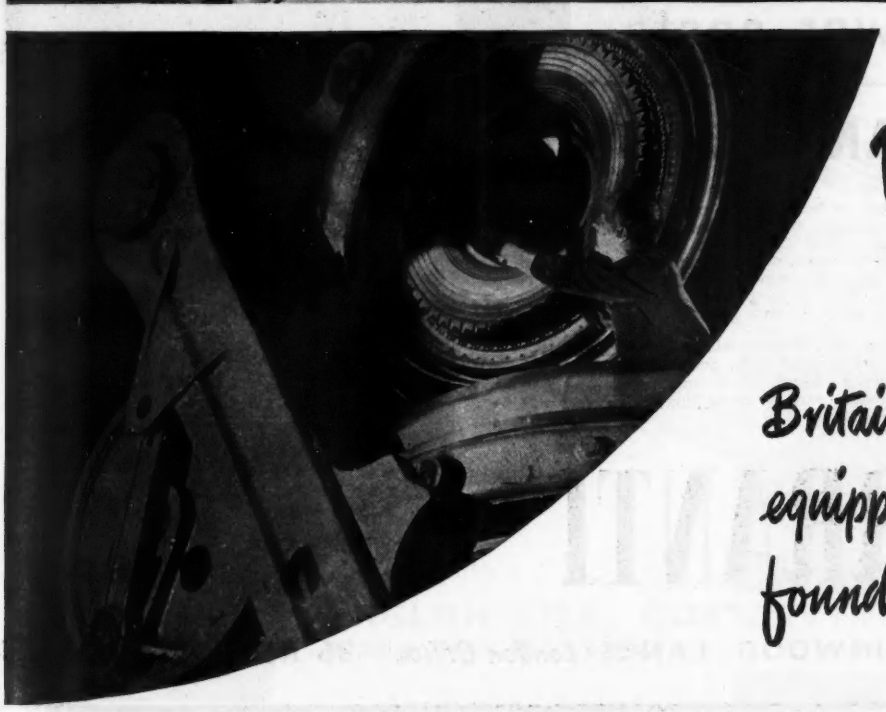

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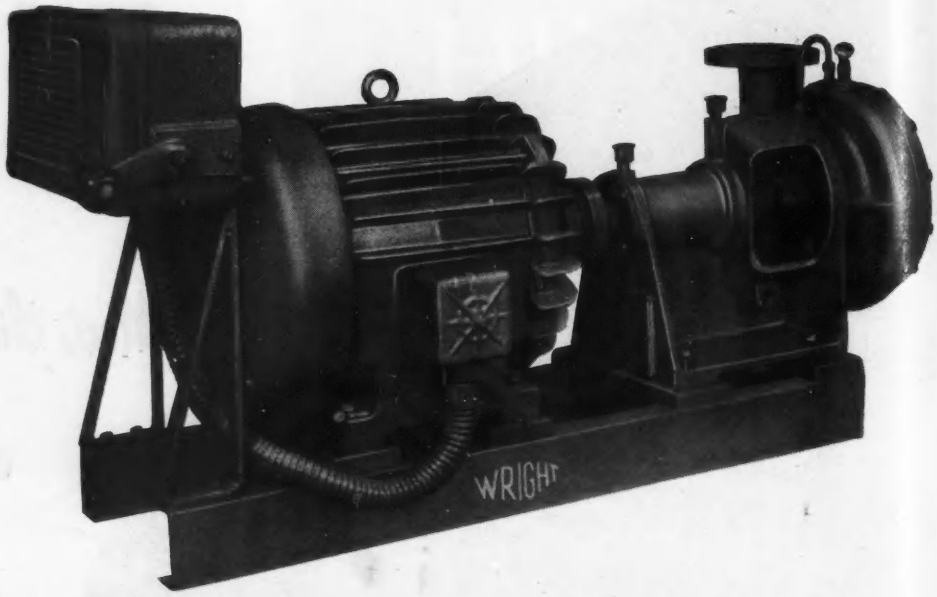

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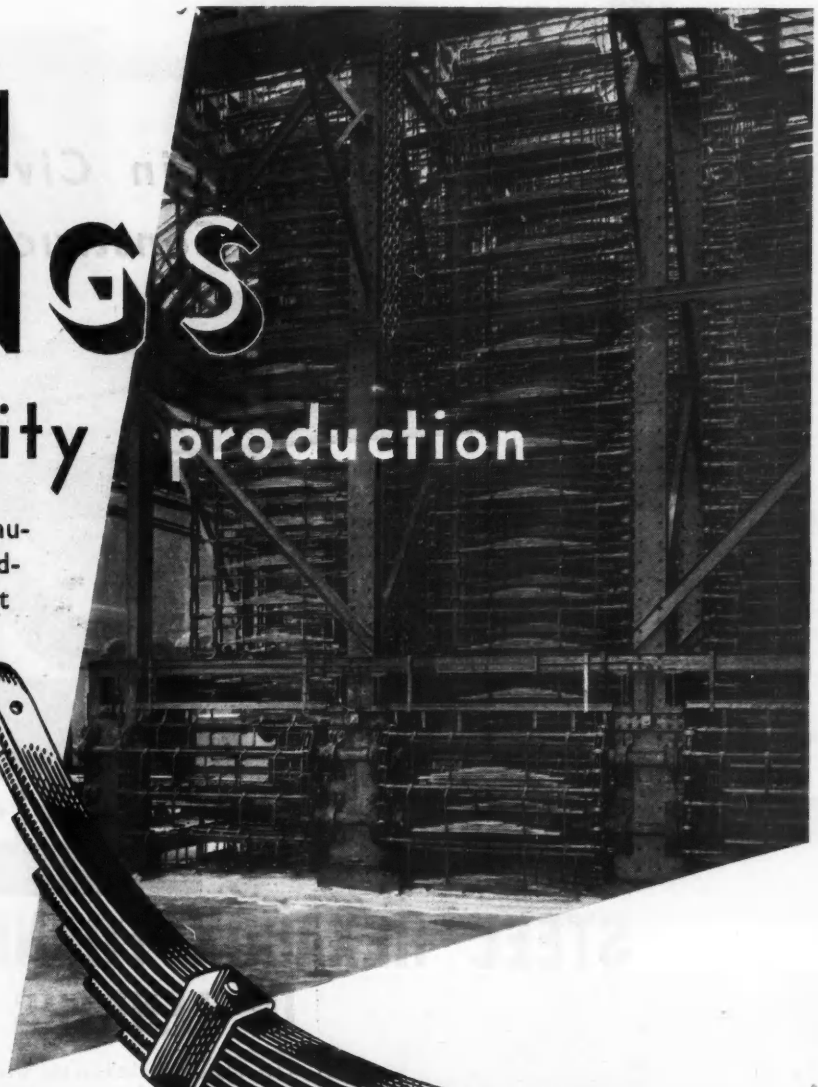

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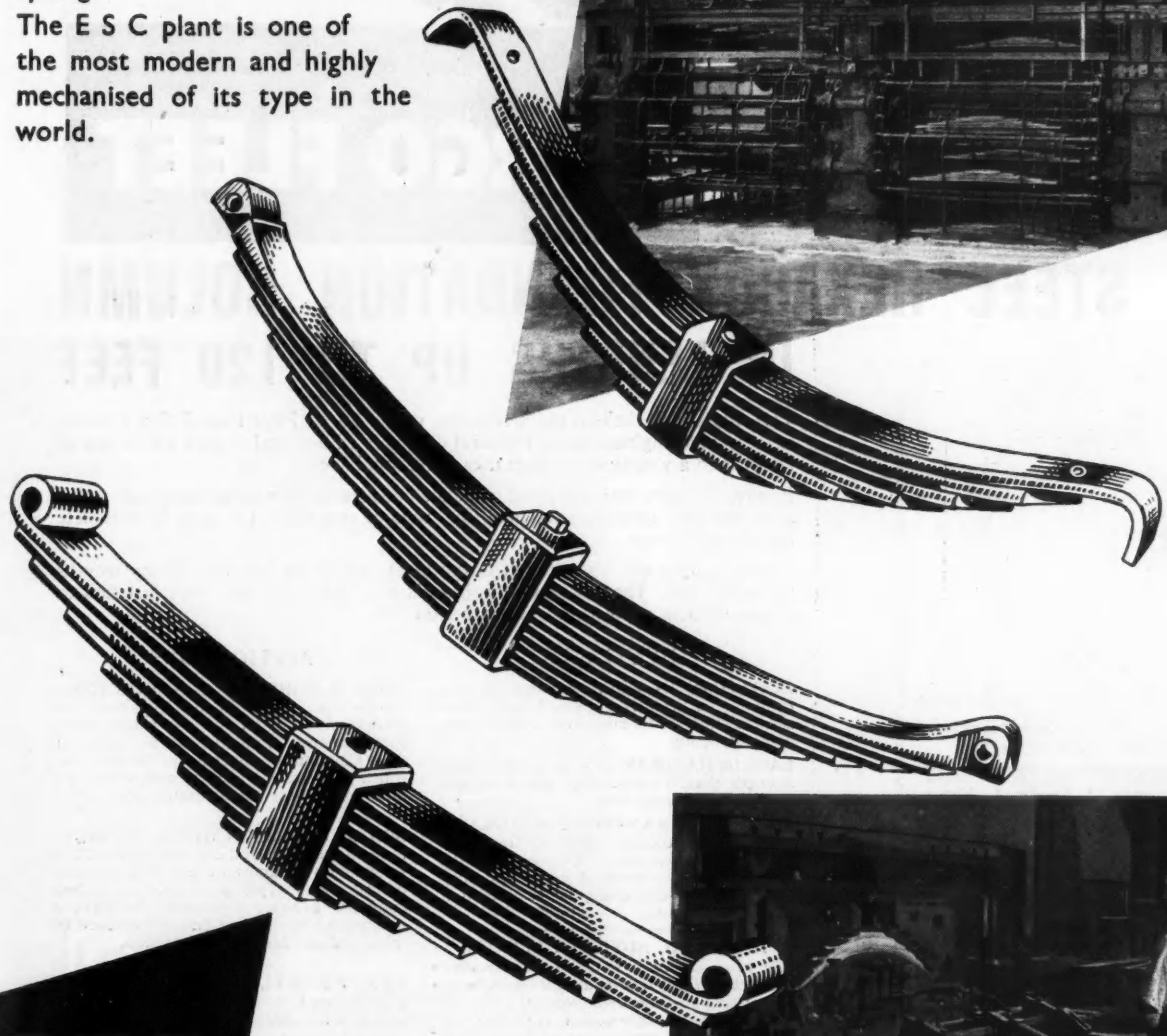

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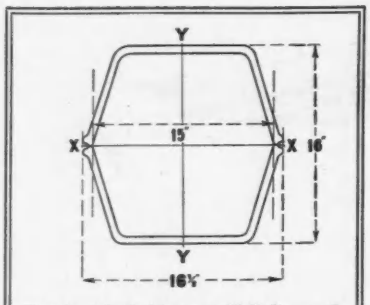

Weight of Rolled Section: 58.30 lbs. per ft.

Weight of Complete Column (including weld): 117.75 lbs. per ft.

About	Moment of Inertia (inches⁴)	Radius of Gyration (inches)	Section Modulus (inches³)
XX	1,214	5.95	151.75
YY	1,038	5.50	125.82

A lighter section (13" x 13") is also available as follows:

Weight of Rolled Section: 36.15 lbs. per ft.

Weight of Complete Column (including weld): 72.50 lbs. per ft.

XX	469.26	4.69	72.2
YY	381.33	4.23	58.7

THE PURPOSE behind the production of the Cargo Fleet Foundation Column is to provide engineers and structural designers with a steel section which can be adapted to a variety of modern uses at reasonable cost.

Briefly, this new multi-purpose product consists of two semi-hexagonal rolled steel sections specially designed for welding together to form a complete hexagonal column.

These columns are fabricated at Cargo Fleet and can be supplied in any lengths up to 120 feet. The most modern shot blasting equipment has been installed to ensure efficient protection from corrosion.

ADVANTAGES

ECONOMY IN USE. As load-bearing columns, particularly on long lengths, they show distinct economies over other forms of construction.

EASE IN HANDLING. In relation to their strength these columns are light in weight and easily transportable.

SAVING IN TRANSPORT & STORAGE SPACE. The columns "nest" for transportation and shipment. Compared with pre-fabricated columns of equal size they show a tremendous saving in space—both in transit and on site.

TECHNICAL ADVISORY SERVICE

The assistance of a specialist drawing-office and technical staff is at the disposal of engineers and structural designers desirous of obtaining further detailed information regarding the possibilities and applications of Cargo Fleet Foundation Column.

APPLICATIONS

DOCK & HARBOUR CONSTRUCTION. Cargo Fleet Foundation Columns are particularly adapted for use where piling construction is required. The properties of these Columns are superior for the work for which they are designed as compared with other methods of piling construction.

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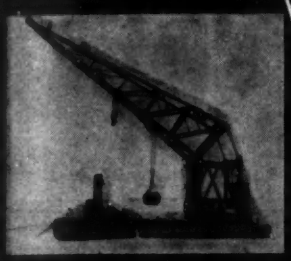

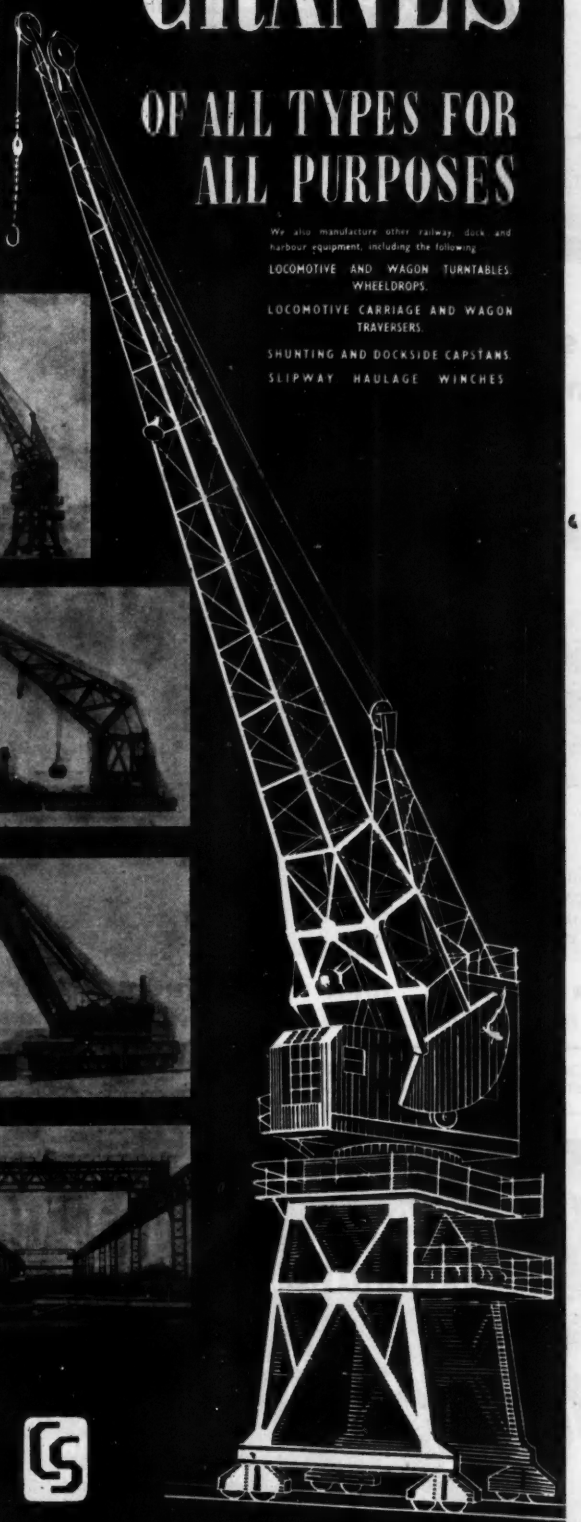

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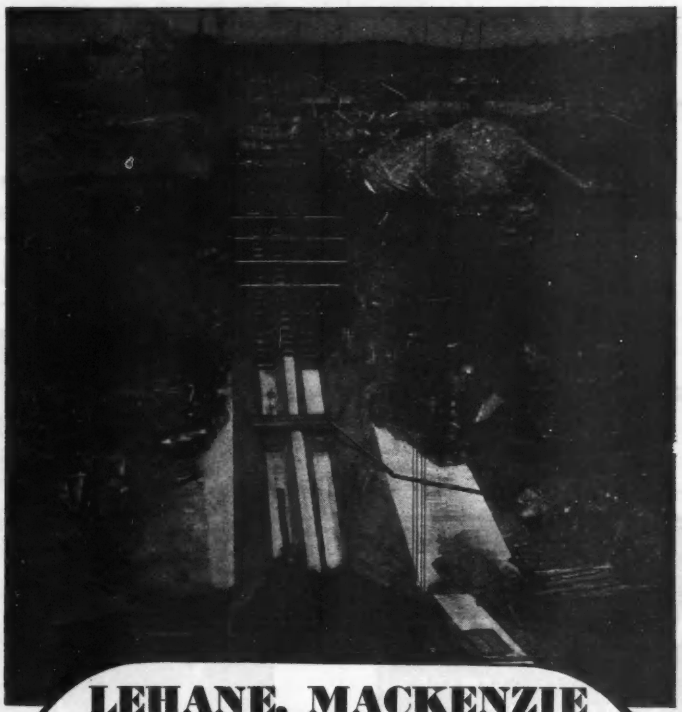

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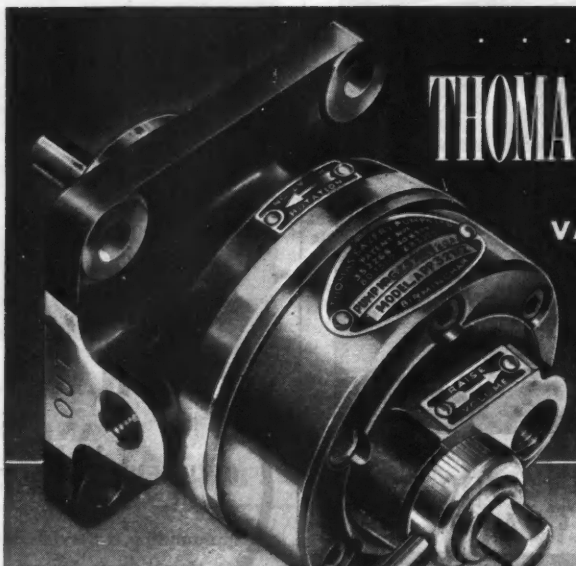

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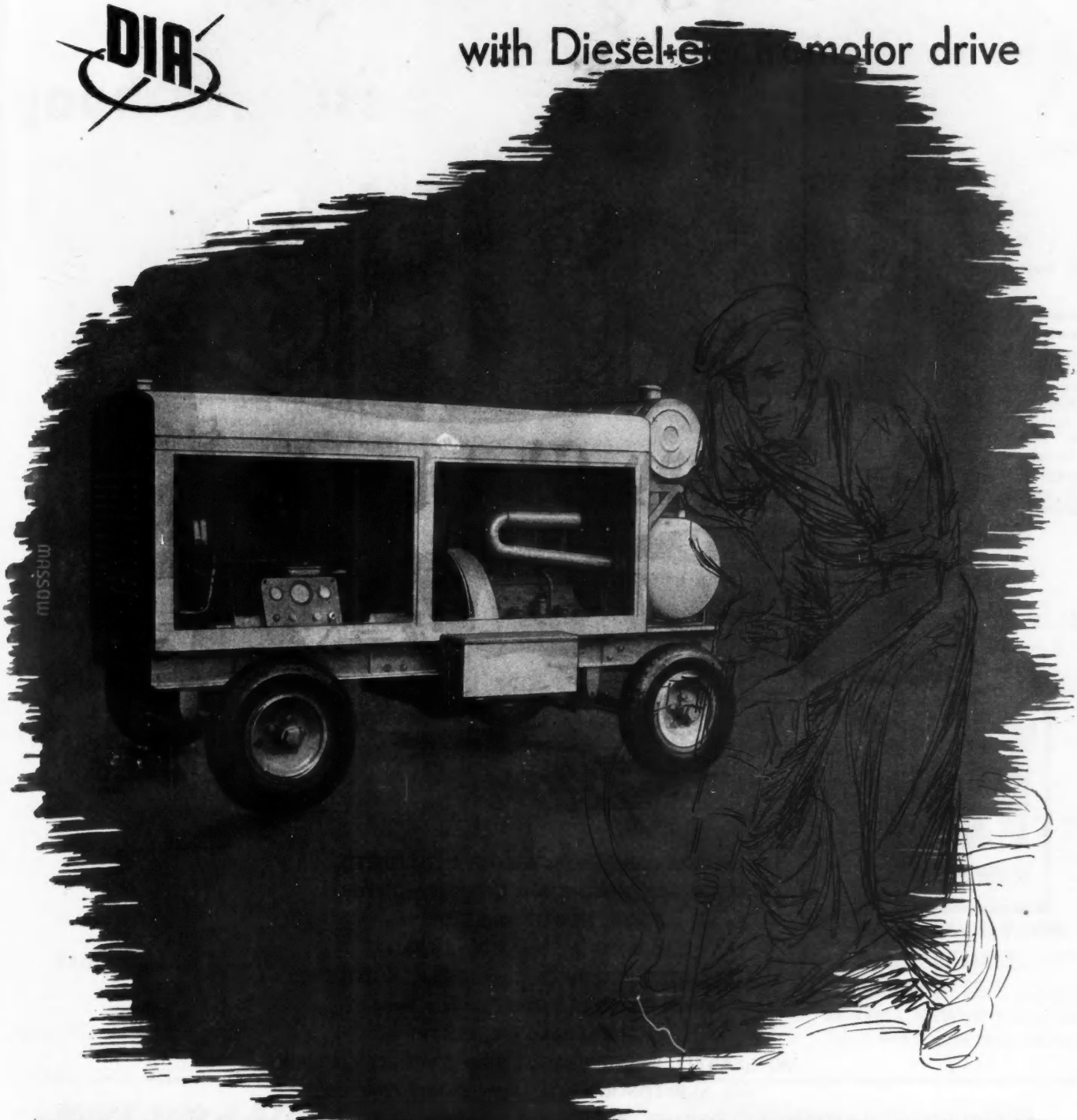

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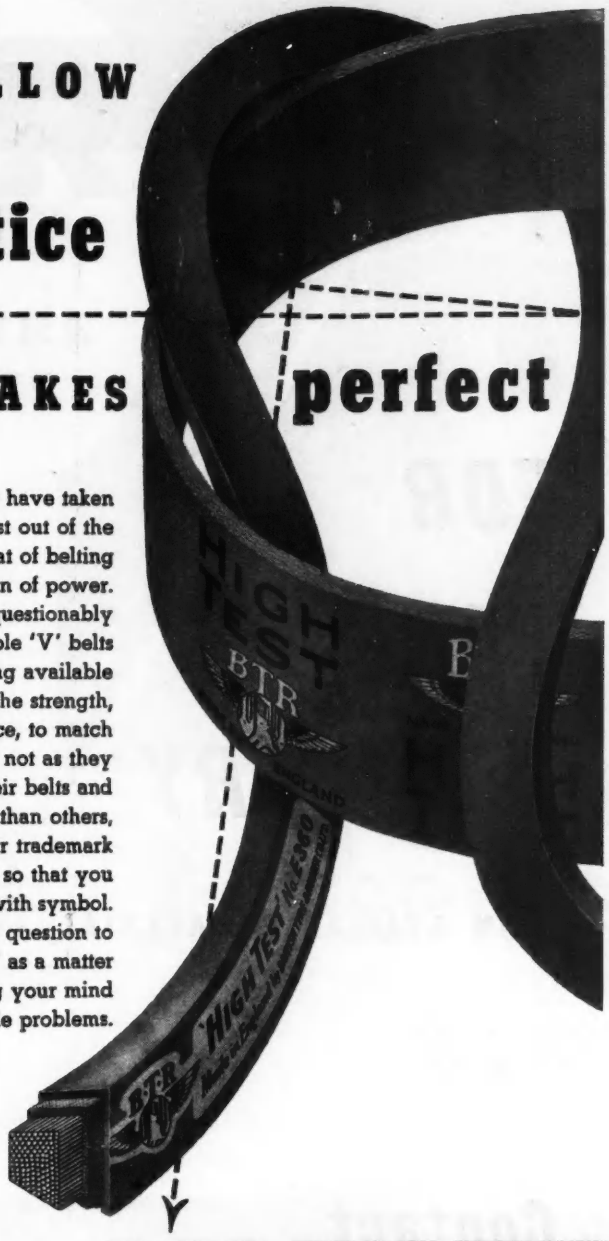

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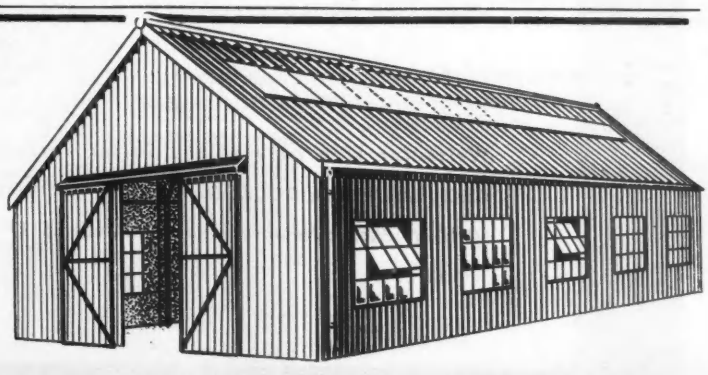

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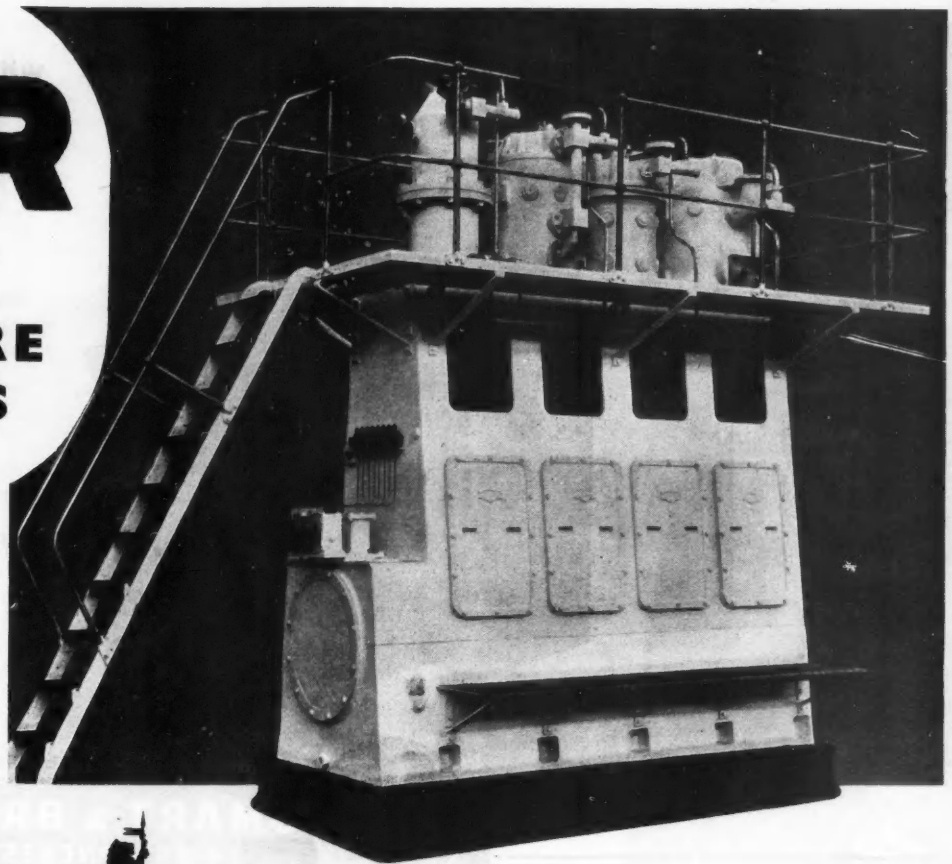

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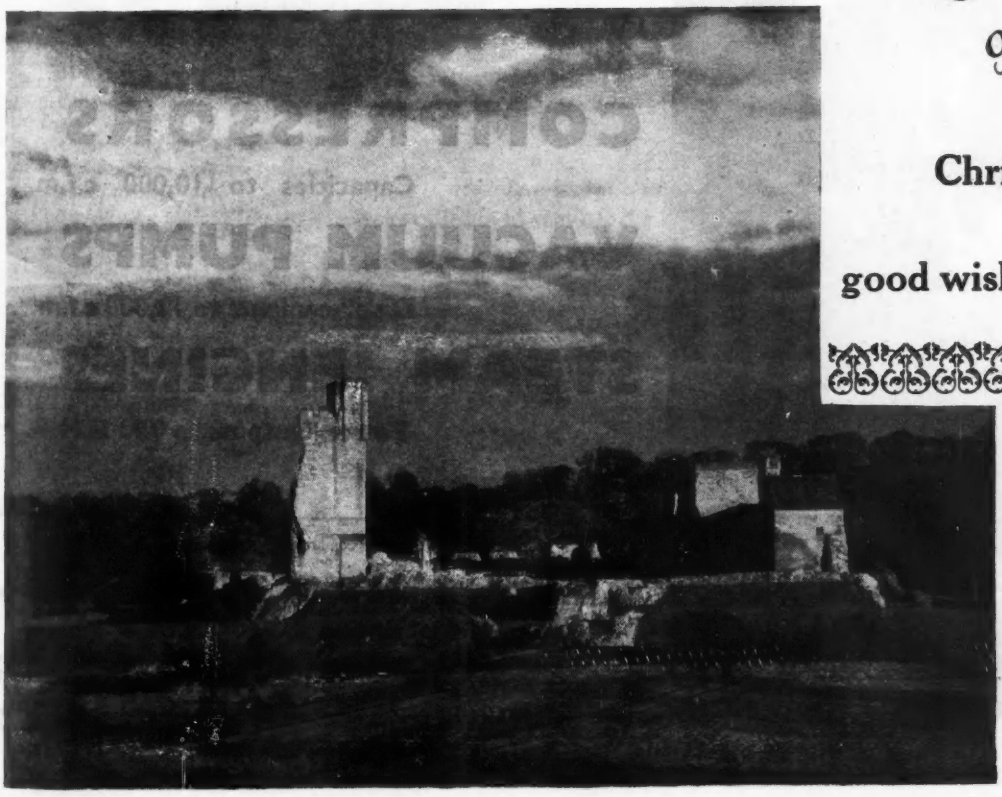

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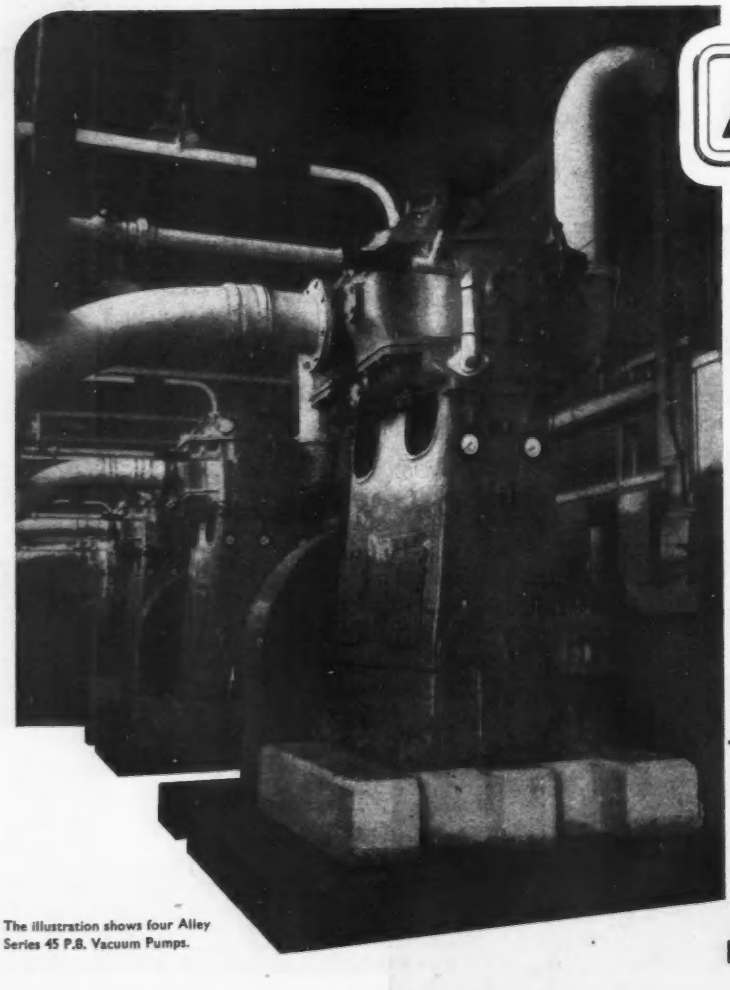

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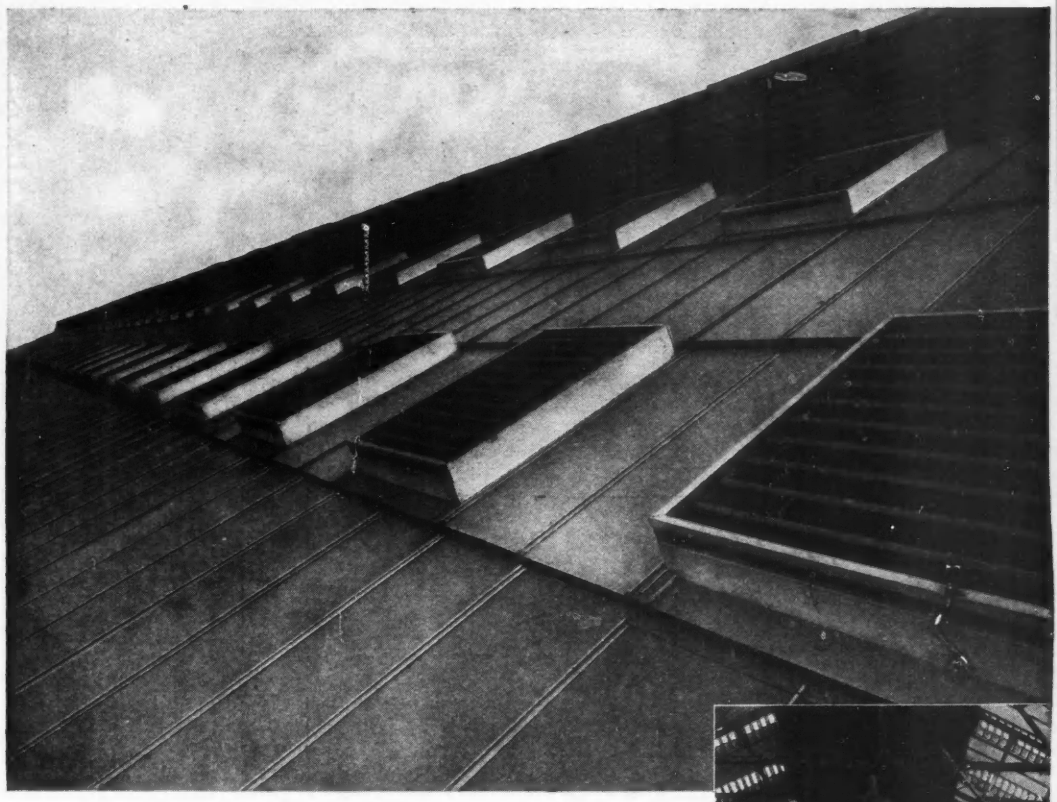

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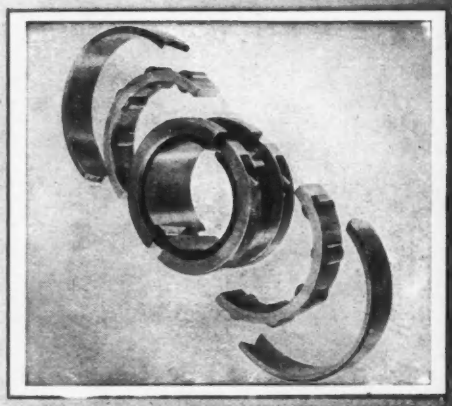

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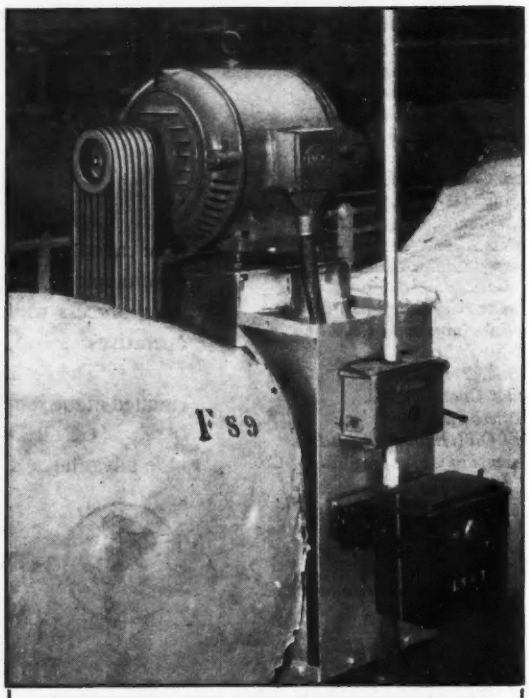

A rayon-drying oven in the factory of British Enka Limited at Aintree. Tough Goodyear Rayon Cord V-Belts give dependable service in air temperatures up to 203°F. (Note: the guards have been removed from the V-Belt drive to facilitate photography).

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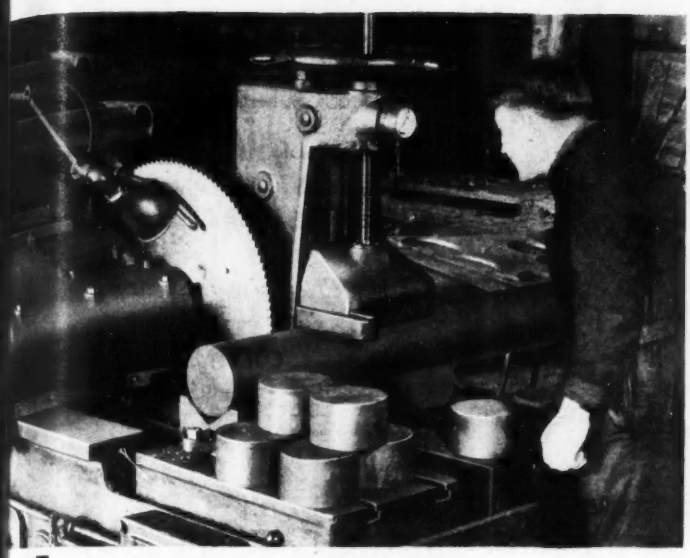

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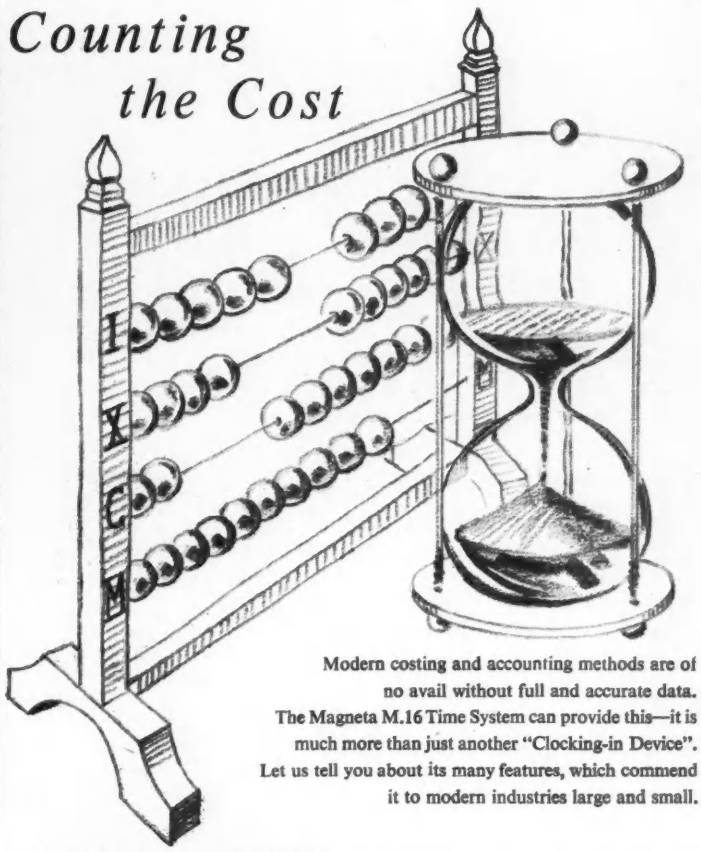

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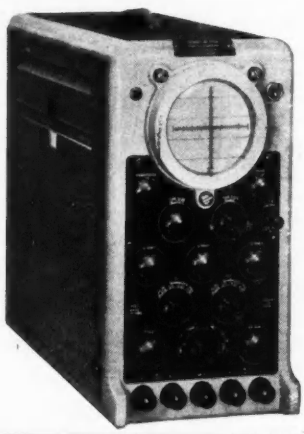

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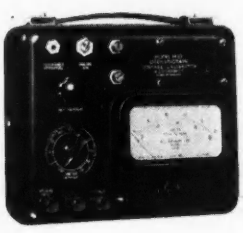

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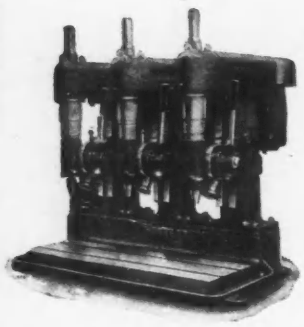

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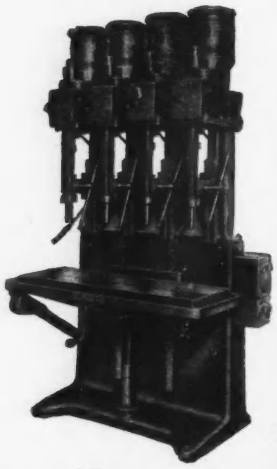

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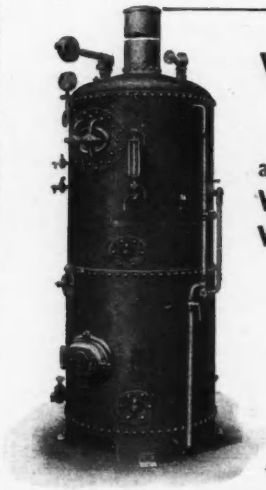

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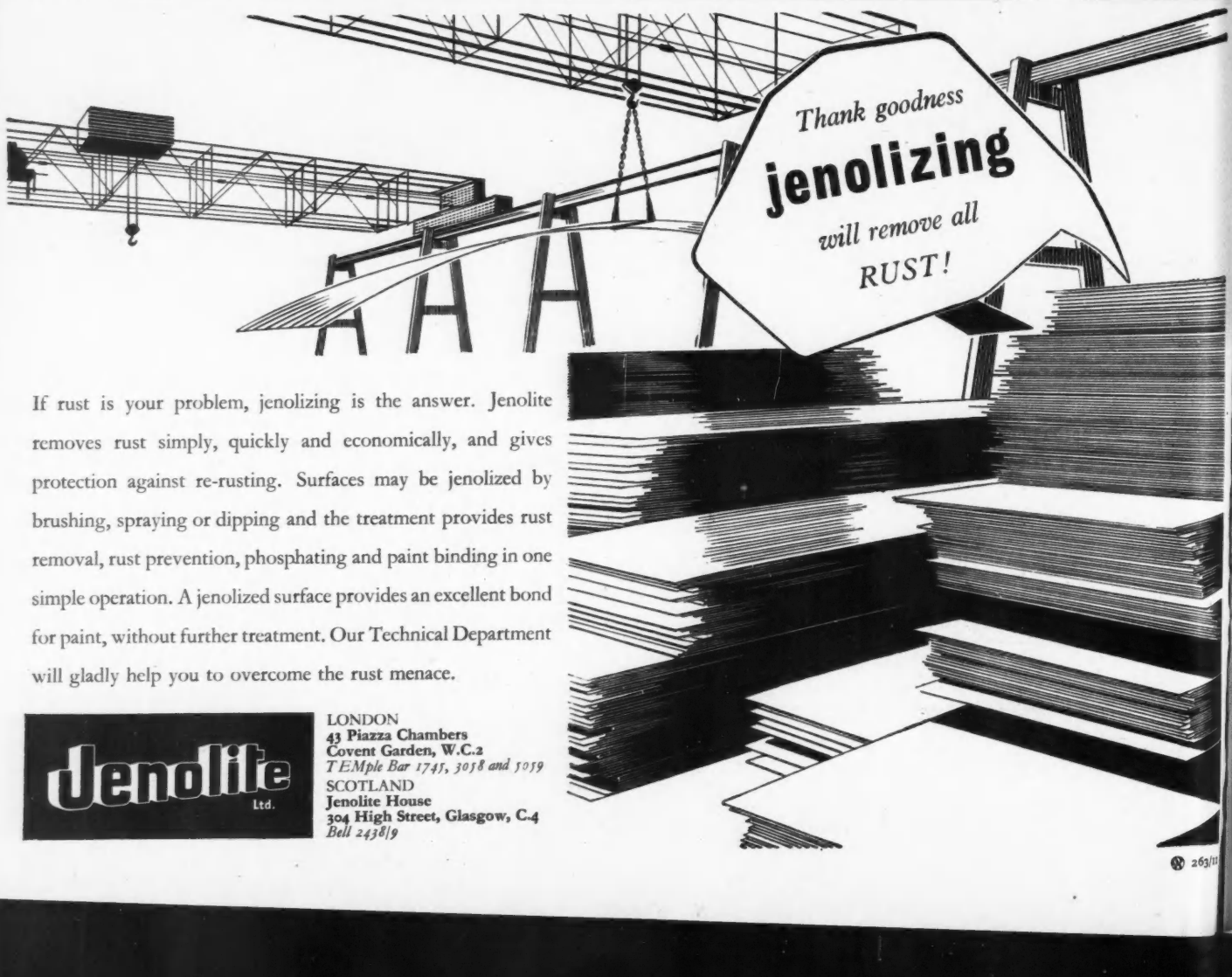

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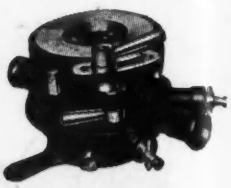

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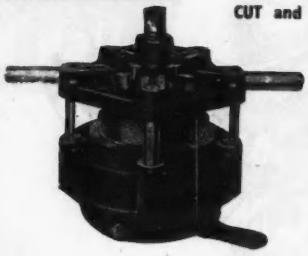

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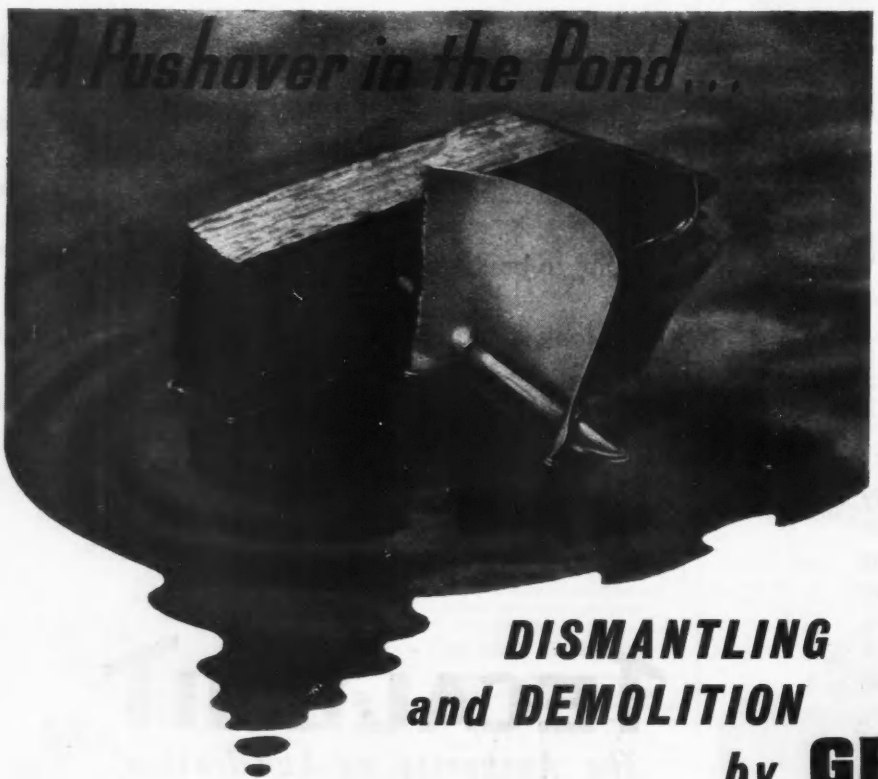

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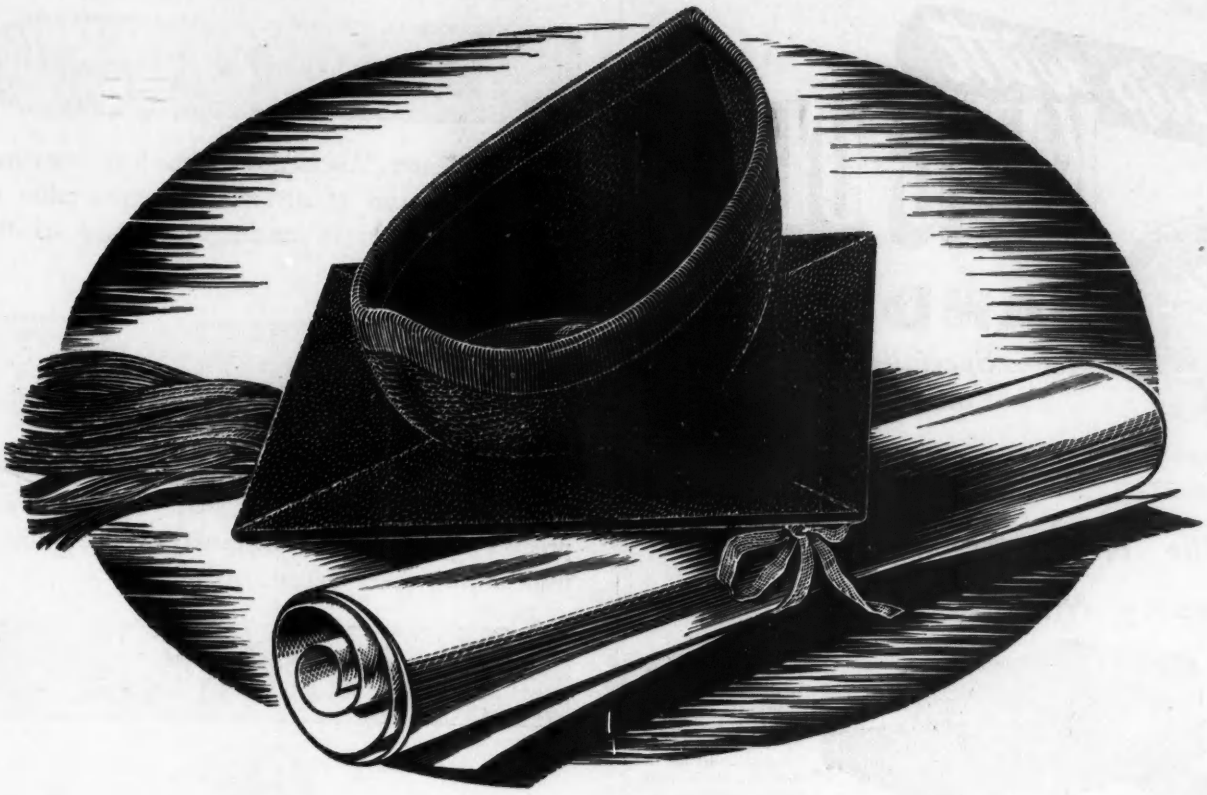

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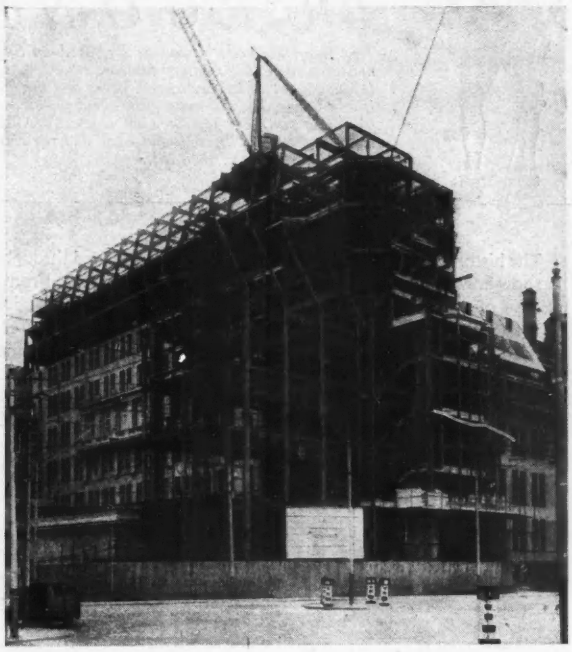

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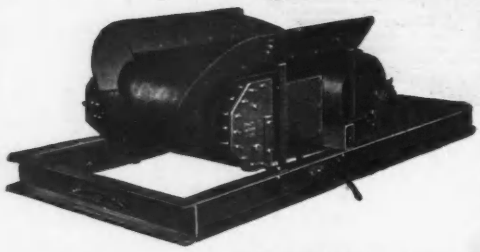

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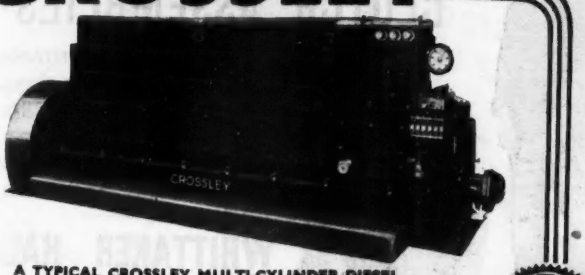

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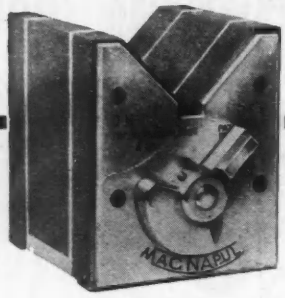

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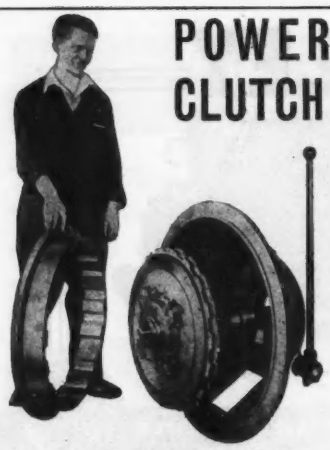

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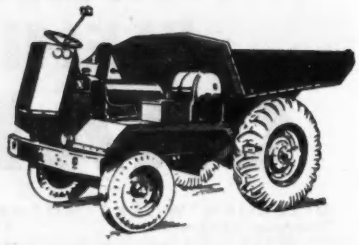

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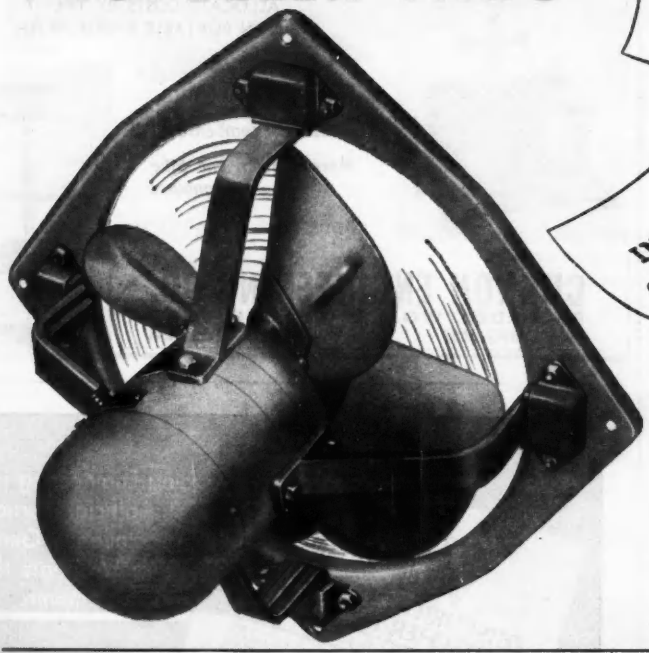

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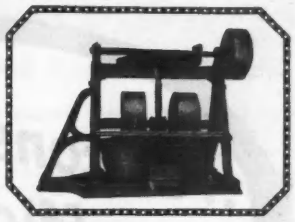

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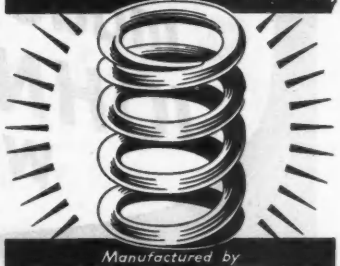

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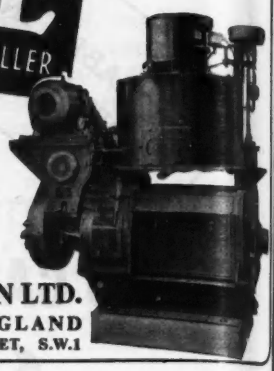

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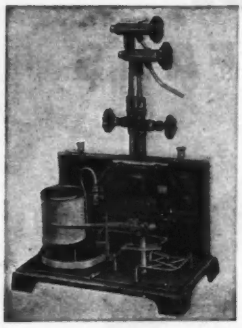

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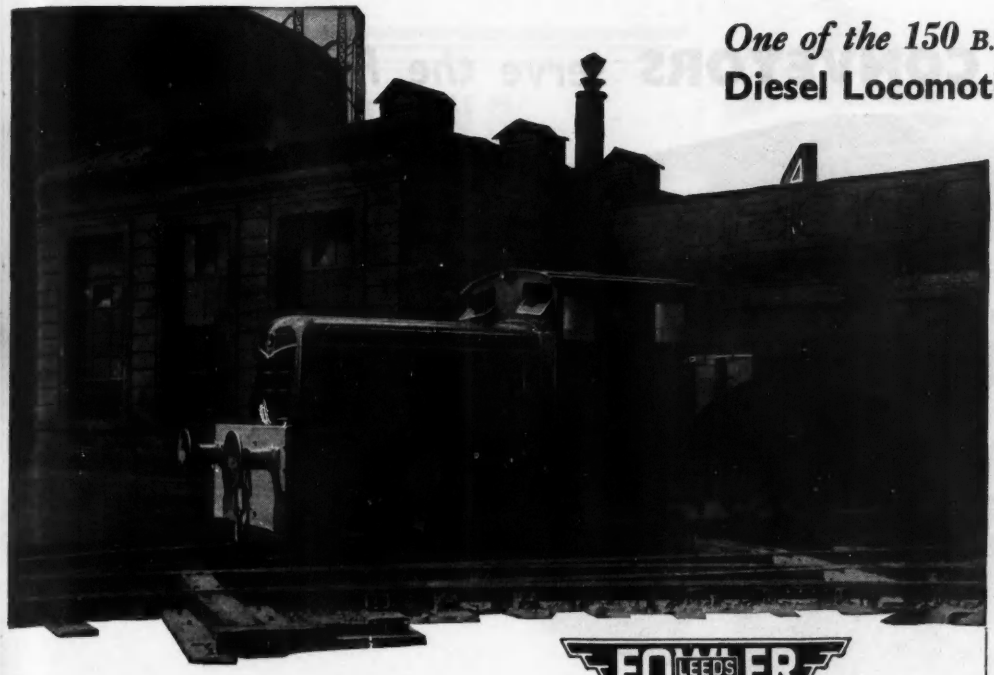

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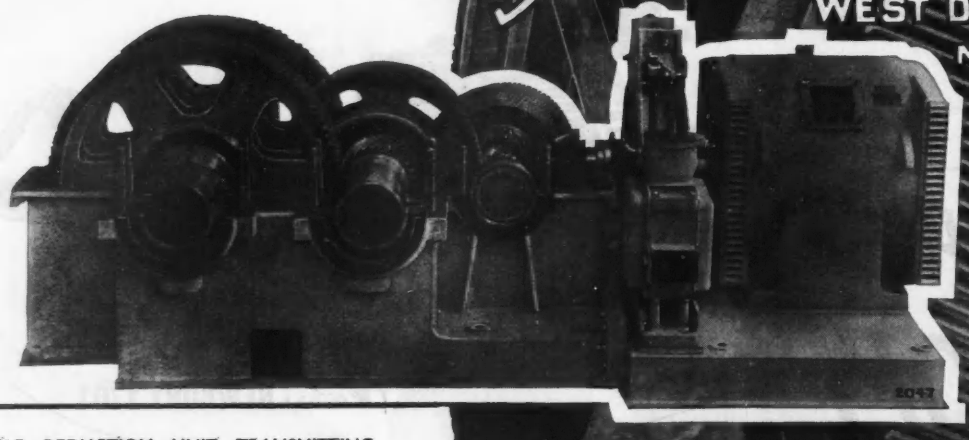

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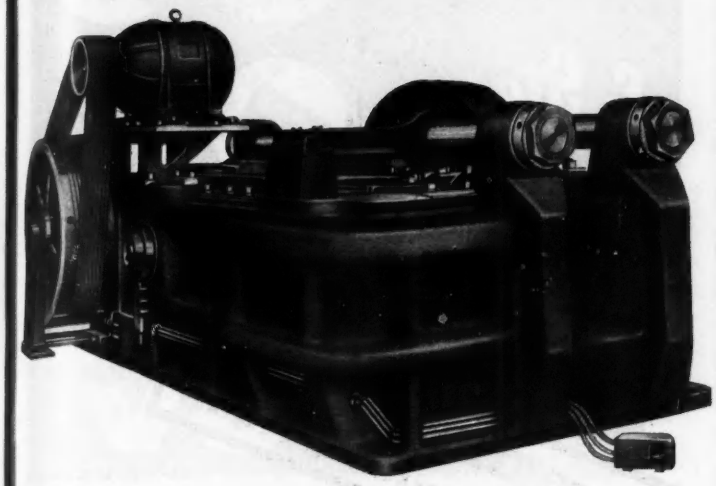

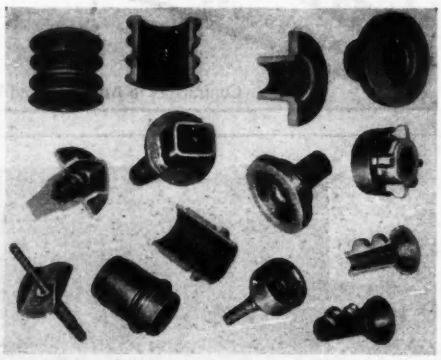

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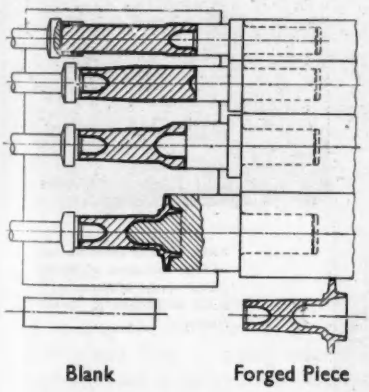

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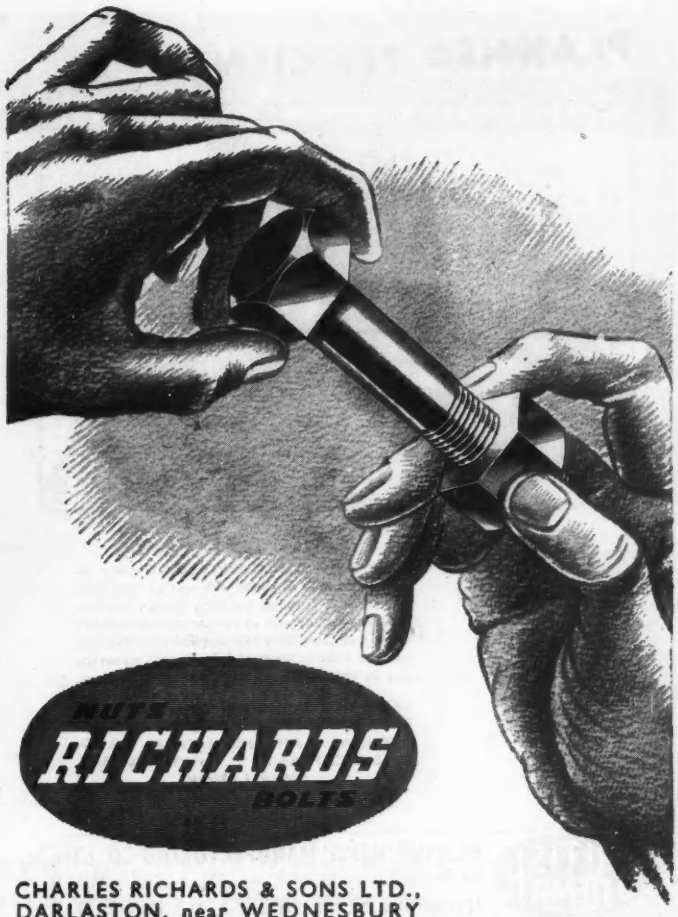

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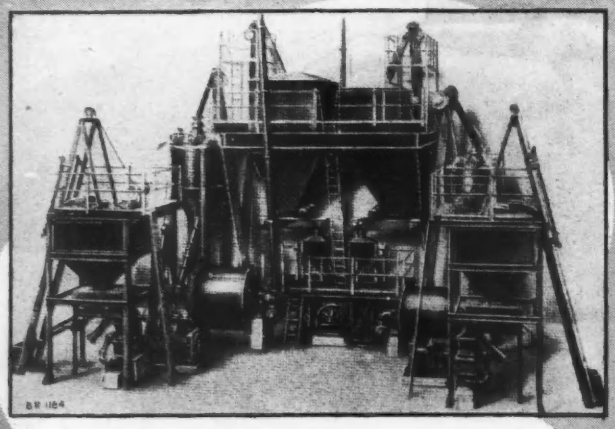

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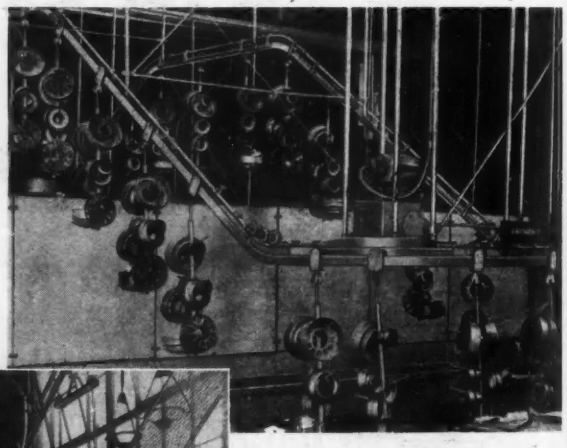

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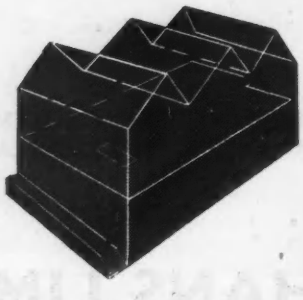
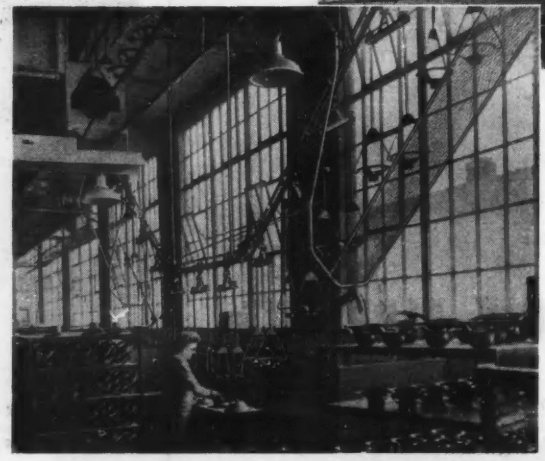


Illustrated is an example of a Teleflex Conveyor which travels all round a particular factory.



Above. Teleflex Conveyors form an important aspect of the production system of Messrs. A. C. Delco — Division of General Motors.

Left. Teleflex Conveyors are important links in the production lines at the works of the Plessey Co. Ltd., Ilford.

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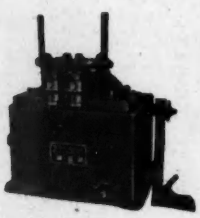

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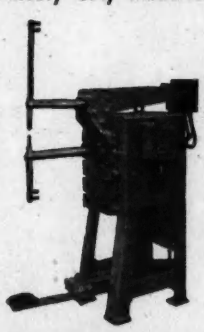

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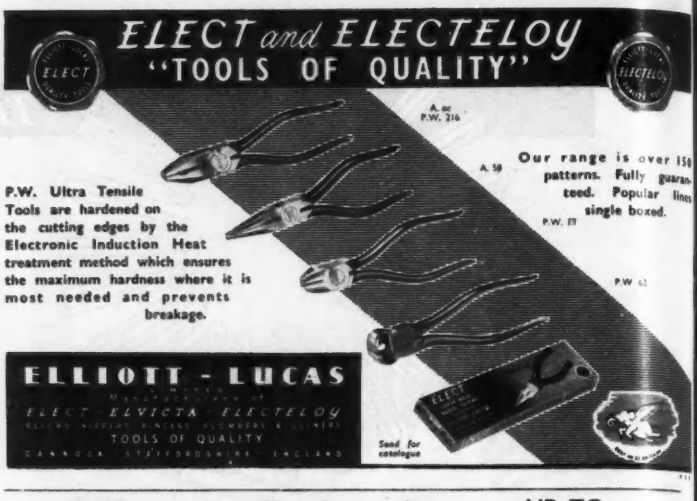

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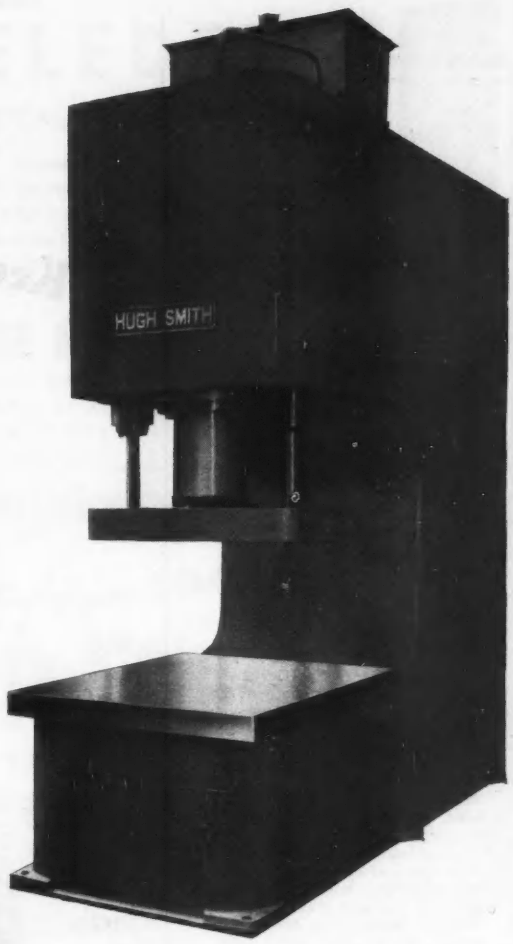

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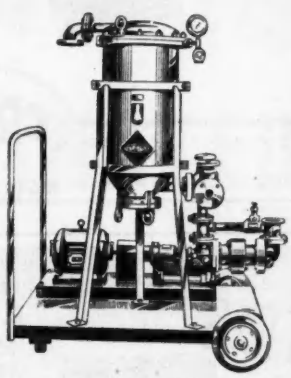

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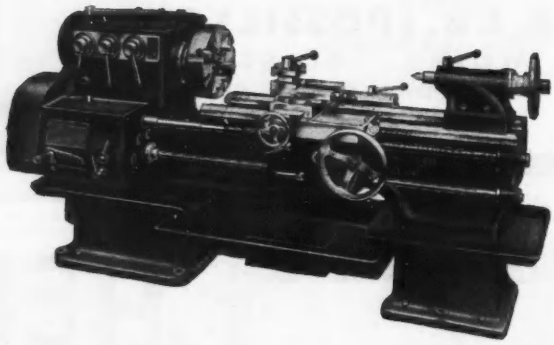

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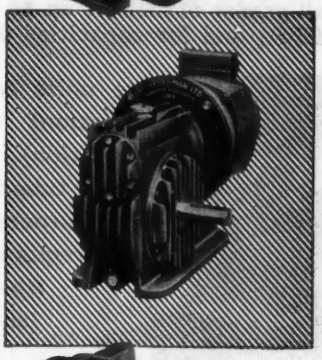

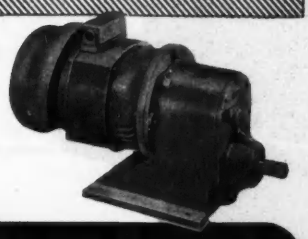

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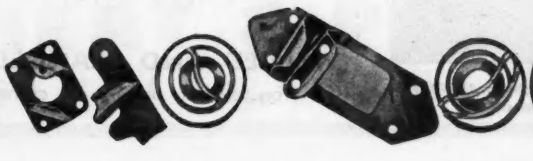

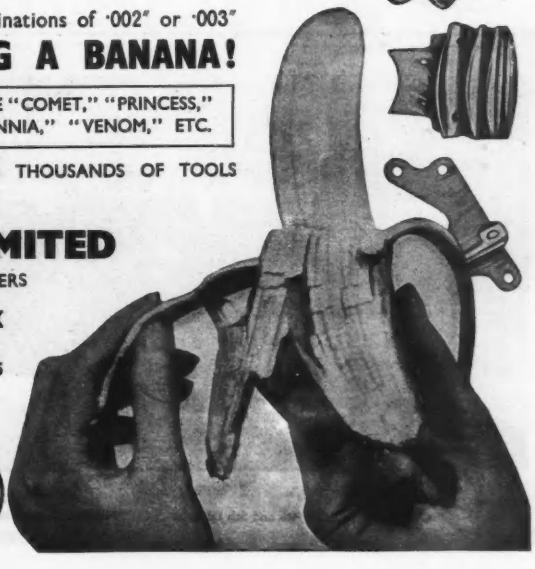

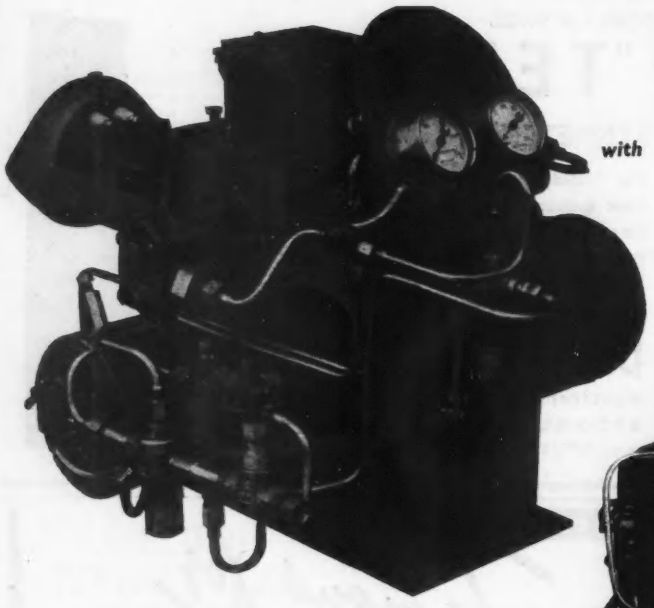

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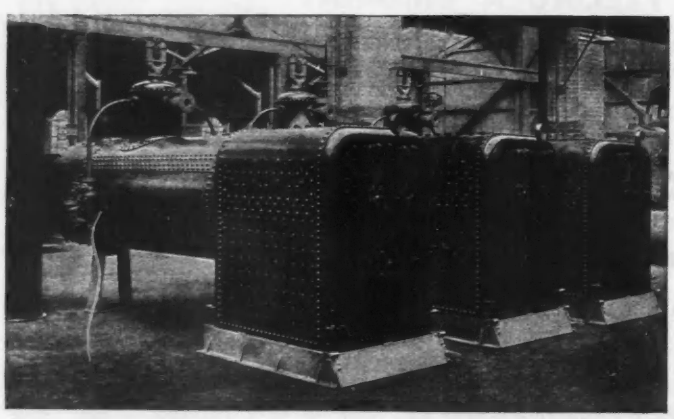

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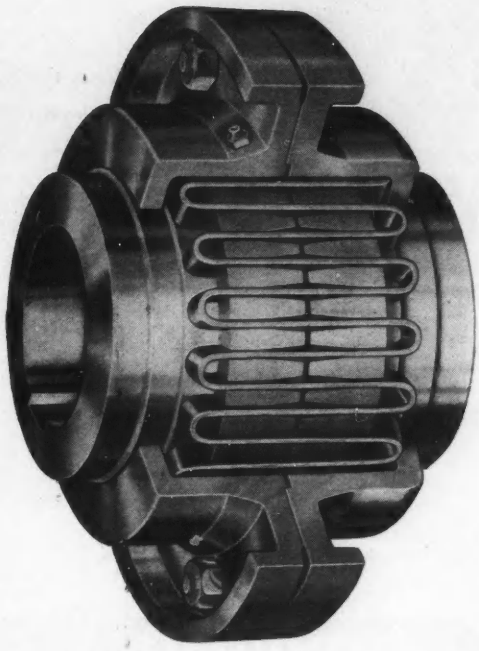

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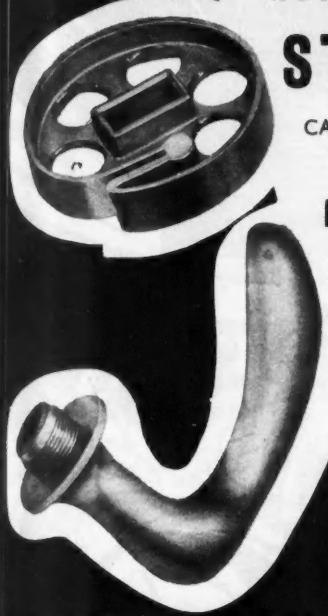

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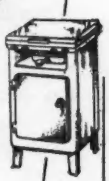

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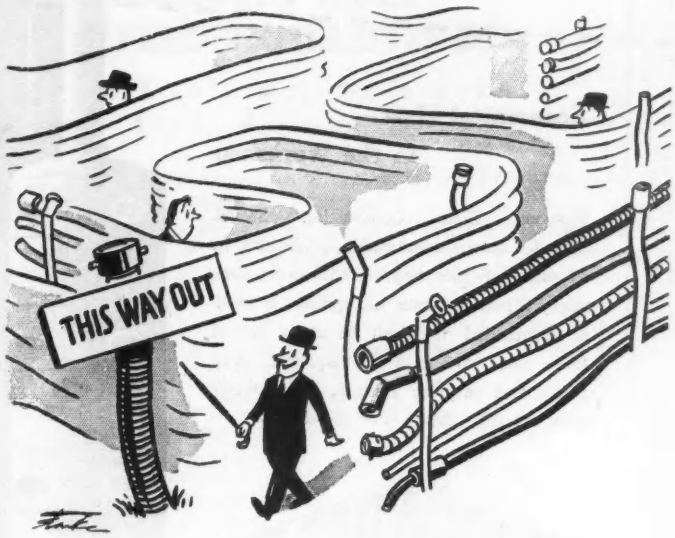

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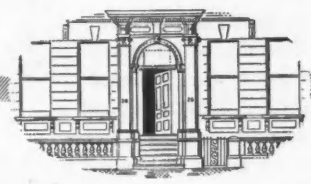

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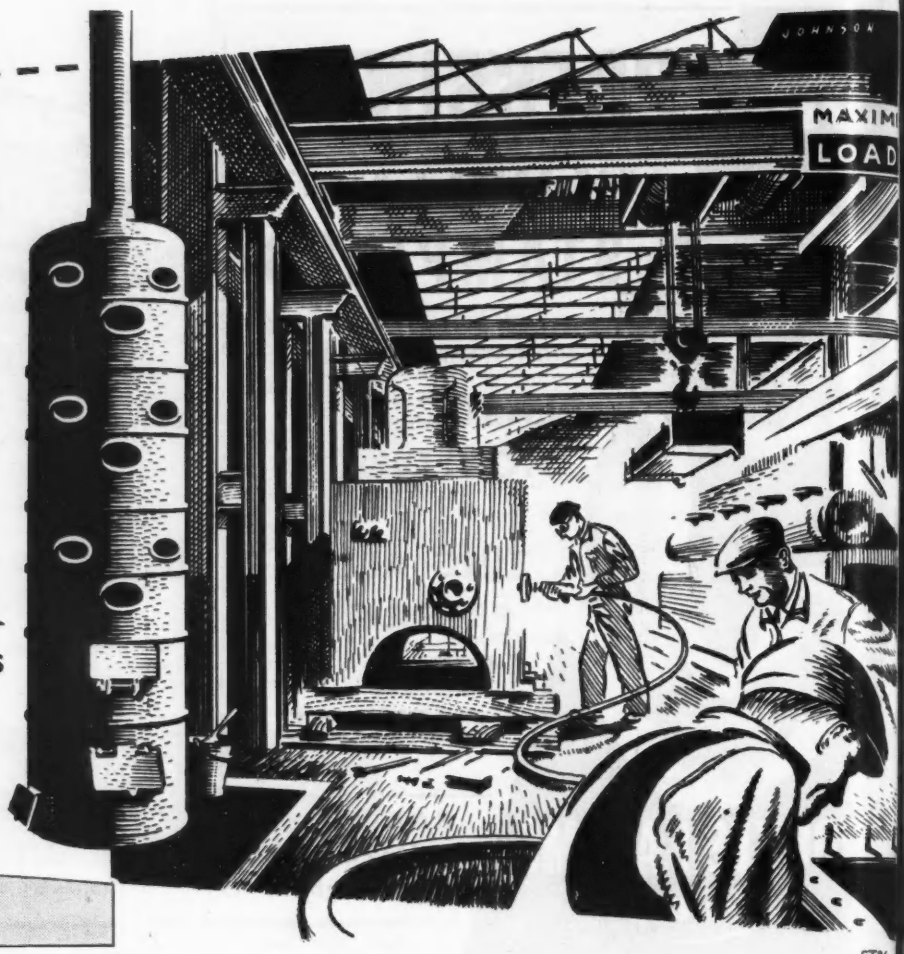

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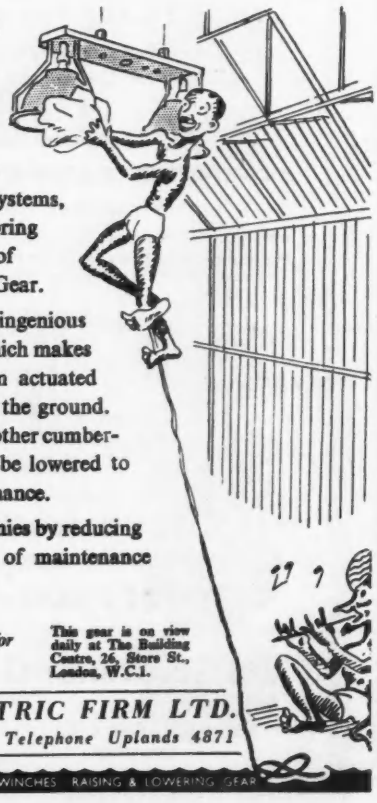

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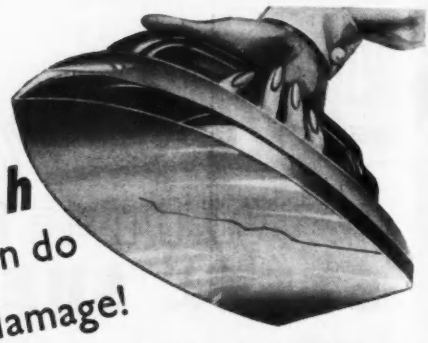

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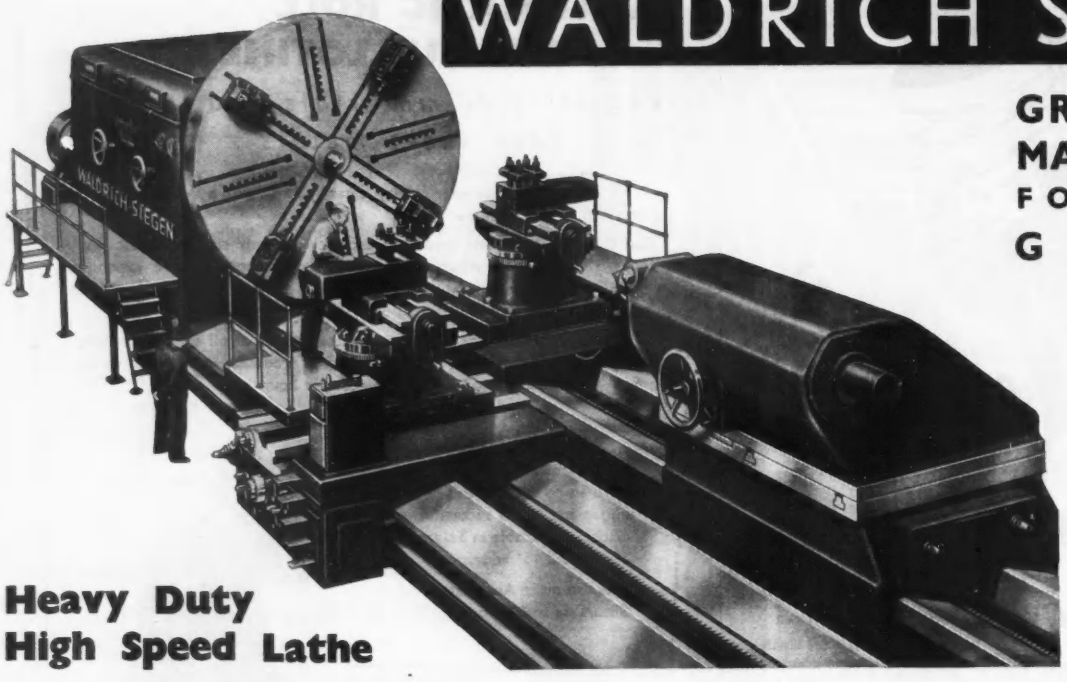

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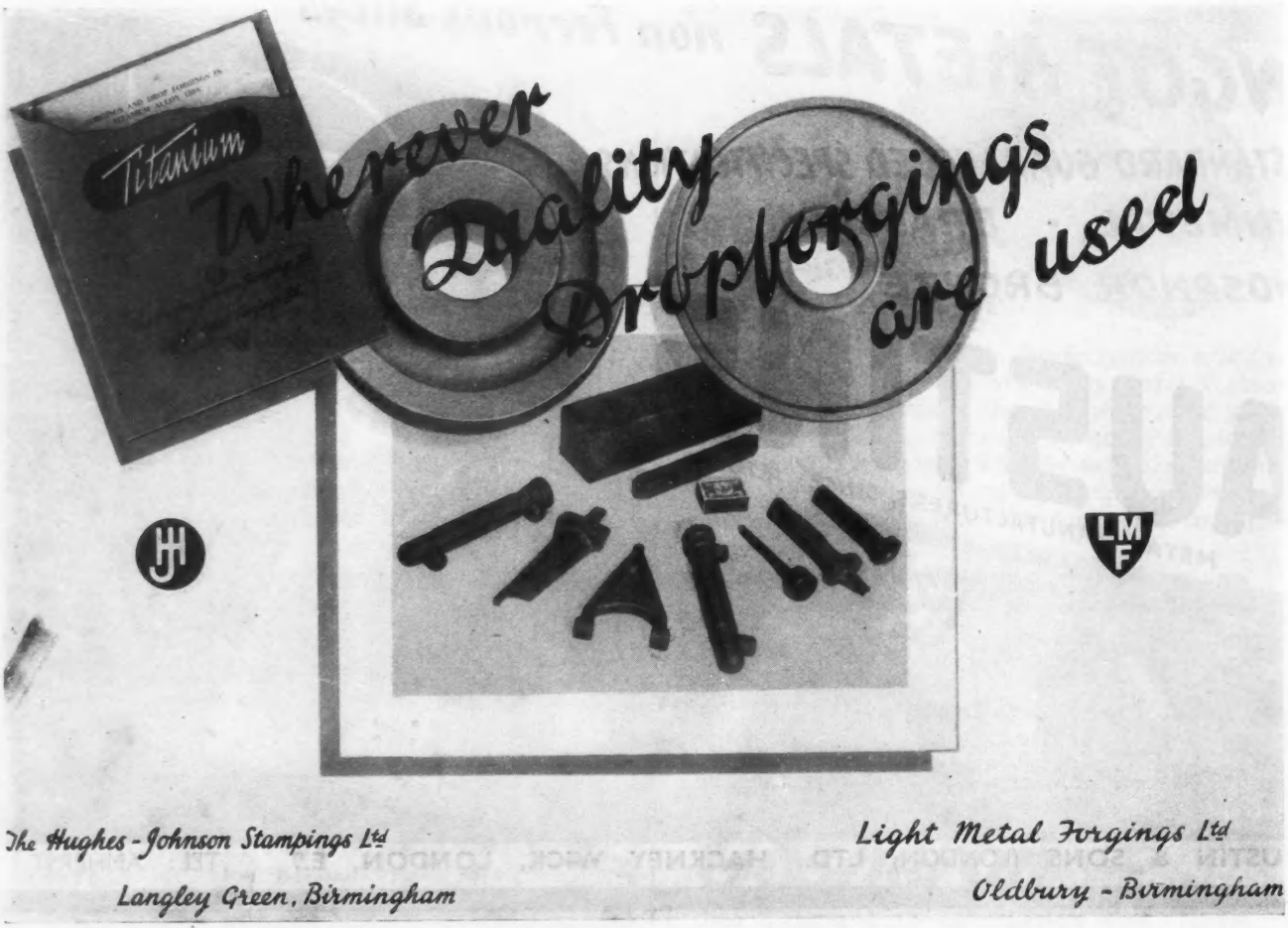

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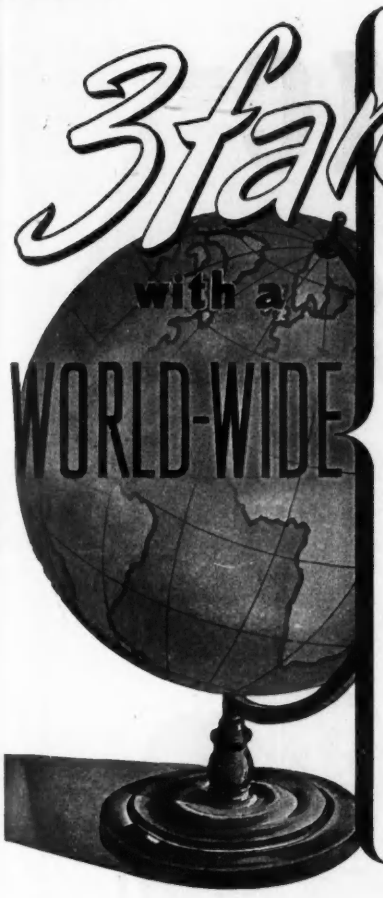
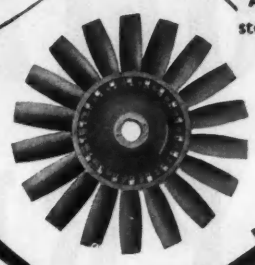


'Aeroto' axial flow fan with fabricated steel adjustable blades.



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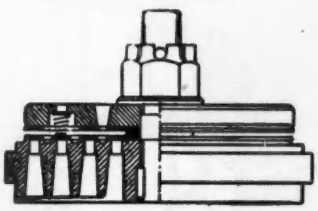

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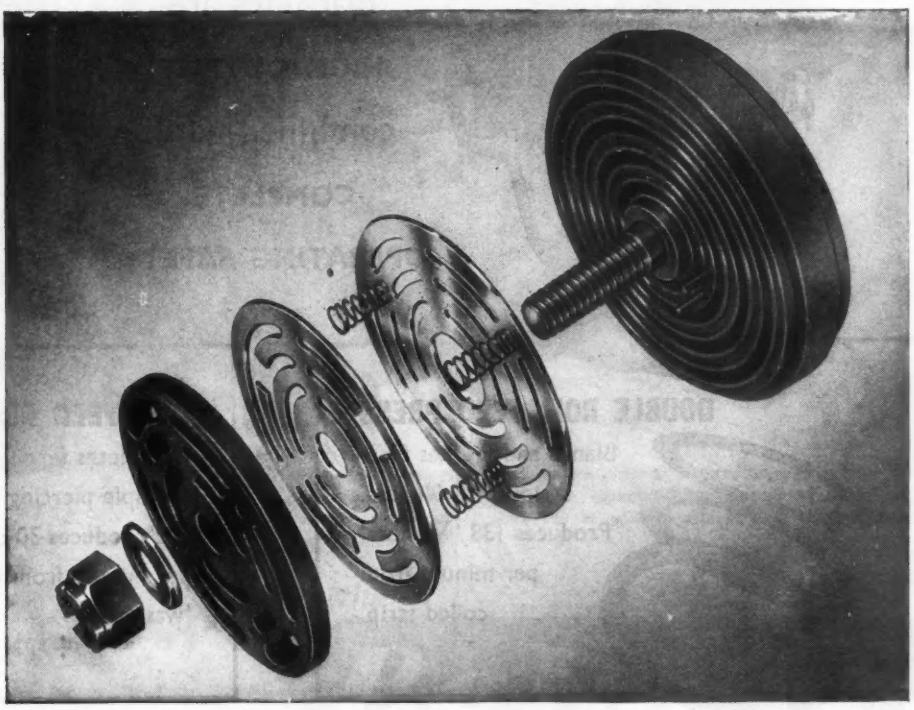

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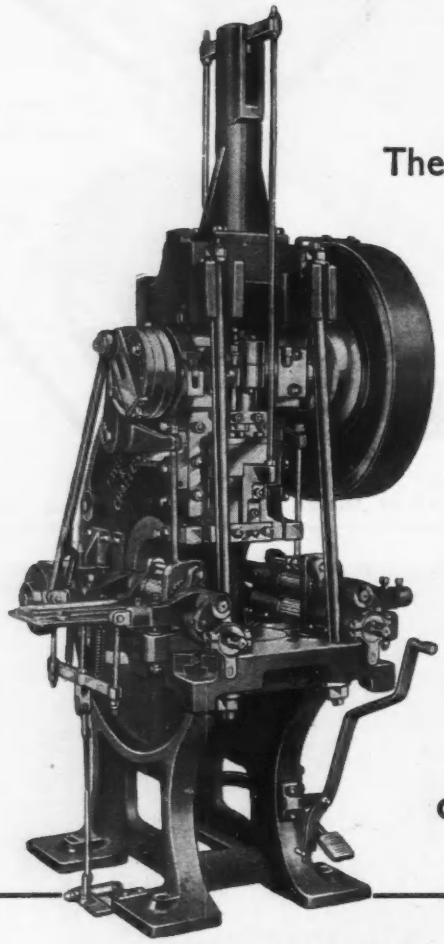

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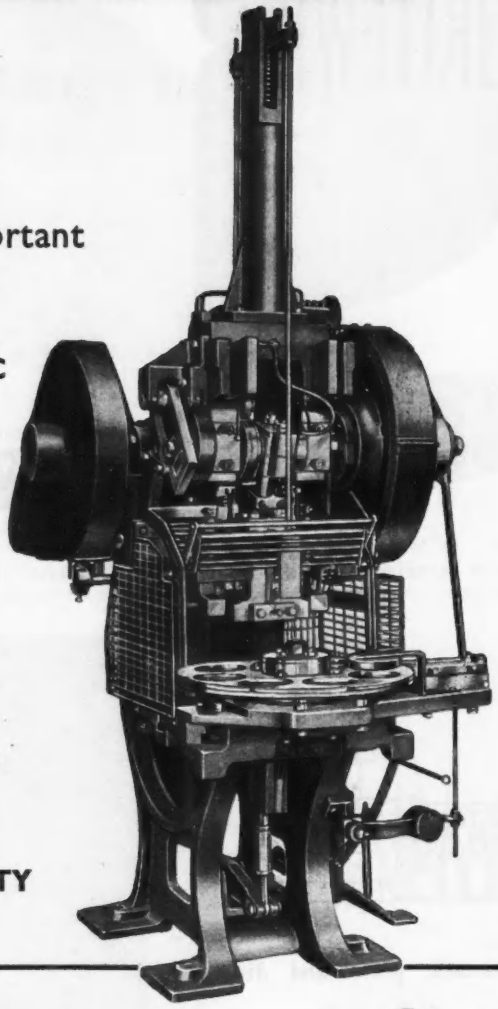

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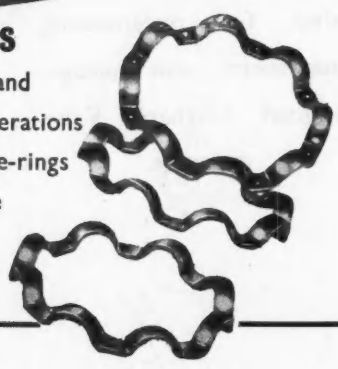

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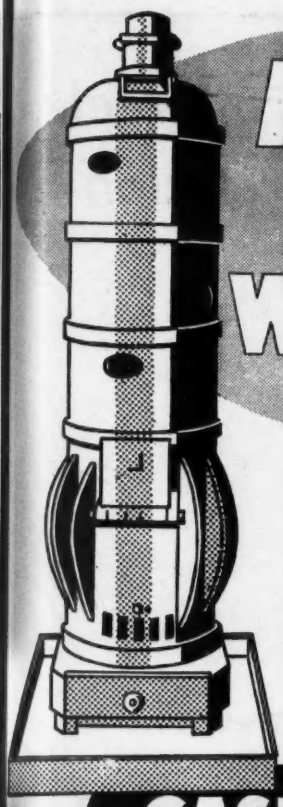

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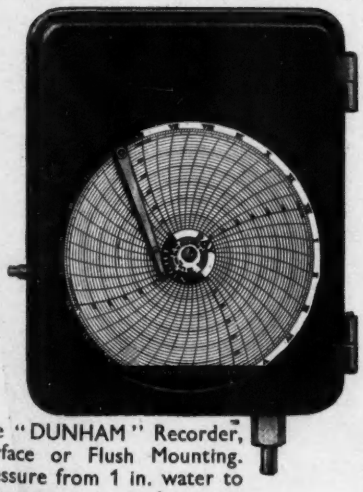

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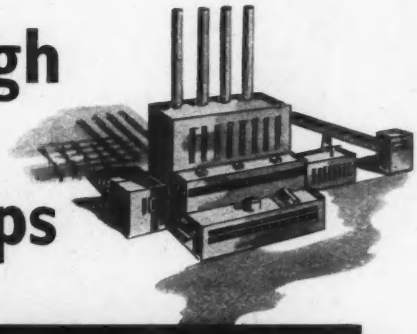

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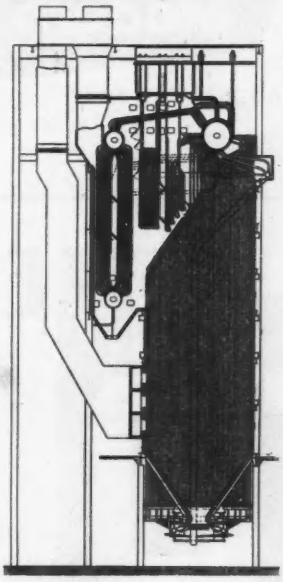

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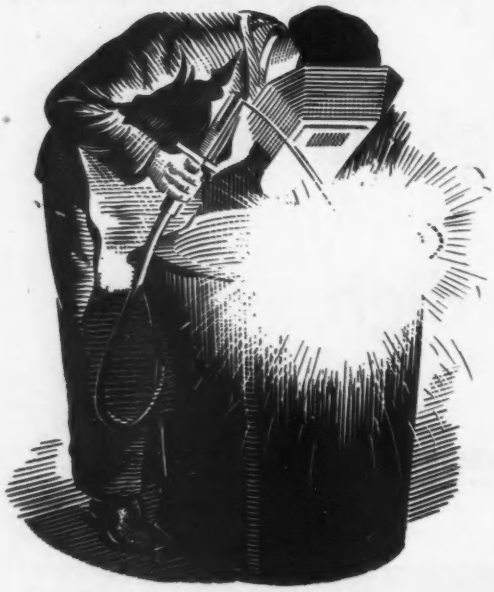

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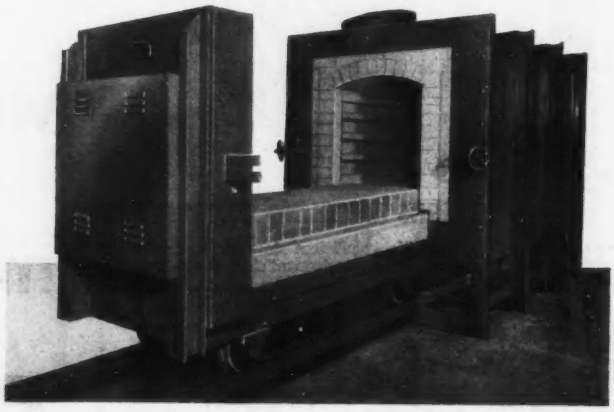

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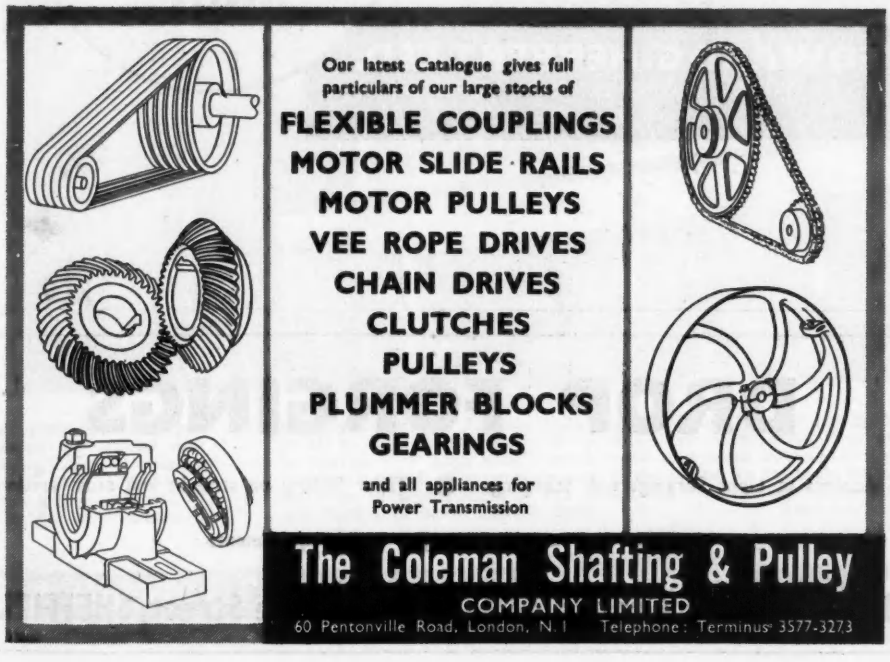

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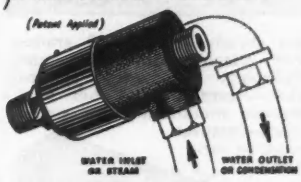

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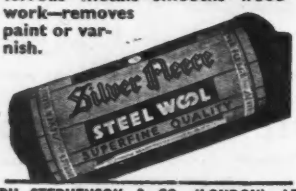

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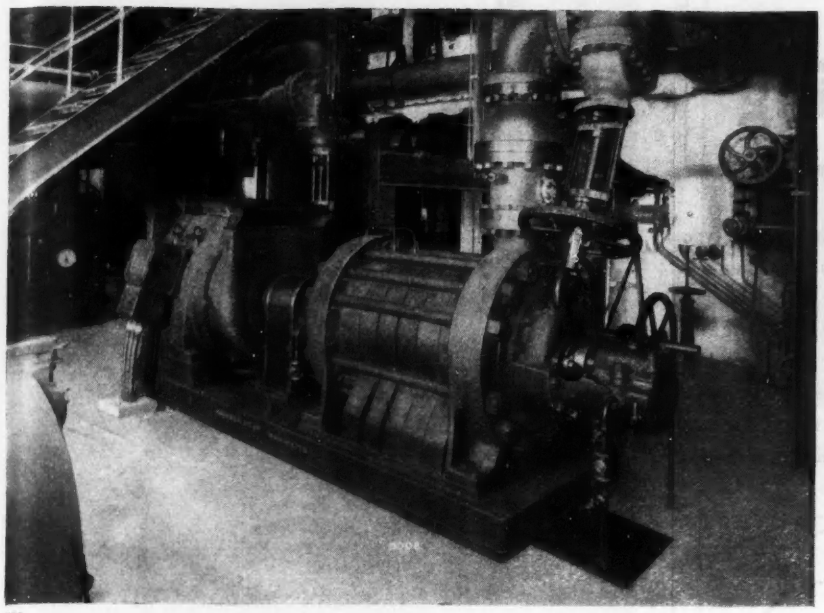

139

This photograph illustrates one of two Boiler Feed Pump units installed at Barton Power Station, B.E.A. The pumps deliver 637,000 lb. per hour at 191°F. and 535 lb. per sq. in. The driving units are 575/600 b.h.p.

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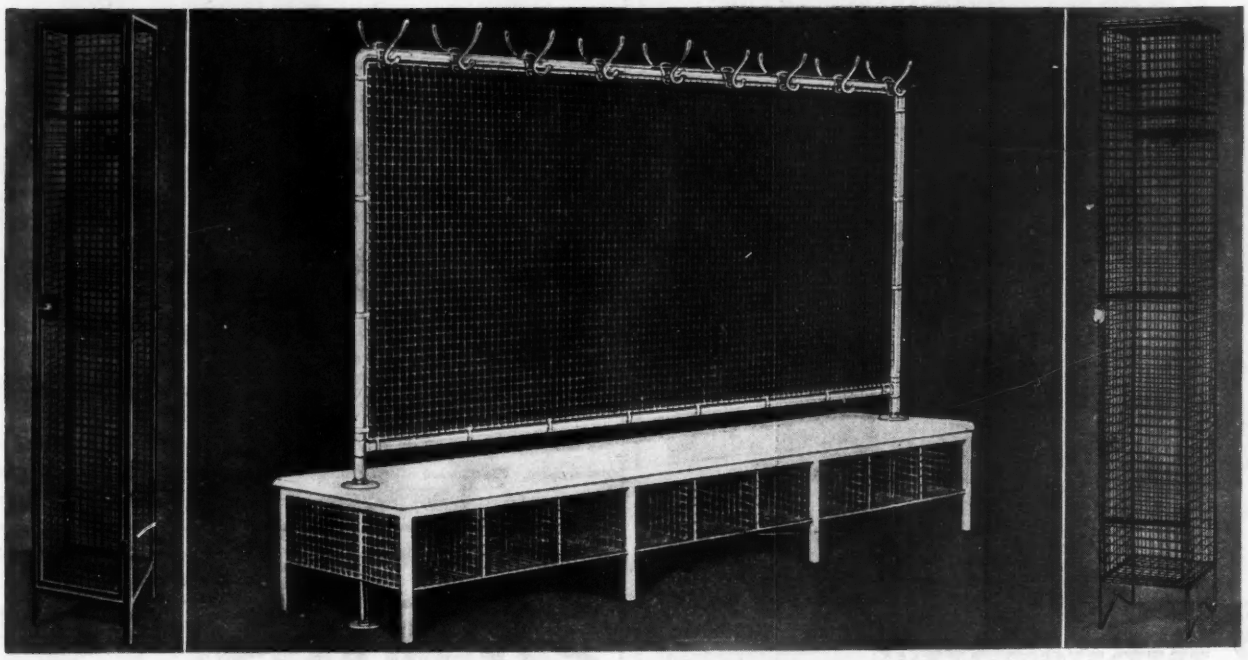

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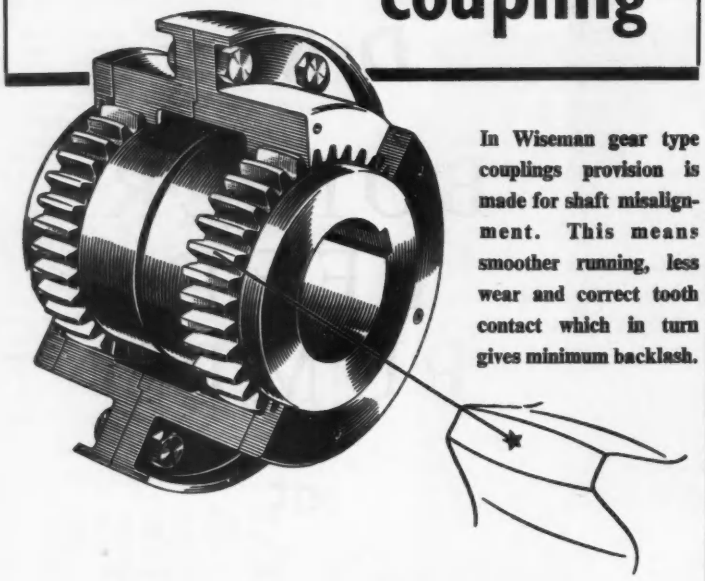
a gear-type coupling



In Wiseman gear type couplings provision is made for shaft misalignment. This means smoother running, less wear and correct tooth contact which in turn gives minimum backlash.

★ *The diagram shows how the teeth of the inner member are "crowned" by a special profile grinding process. These couplings are manufactured from high grade steel, in eleven standard sizes and two types.*

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Box-type pallets handling unit loads of coil springs. (Photograph by courtesy of Elson & Robbins Ltd.)

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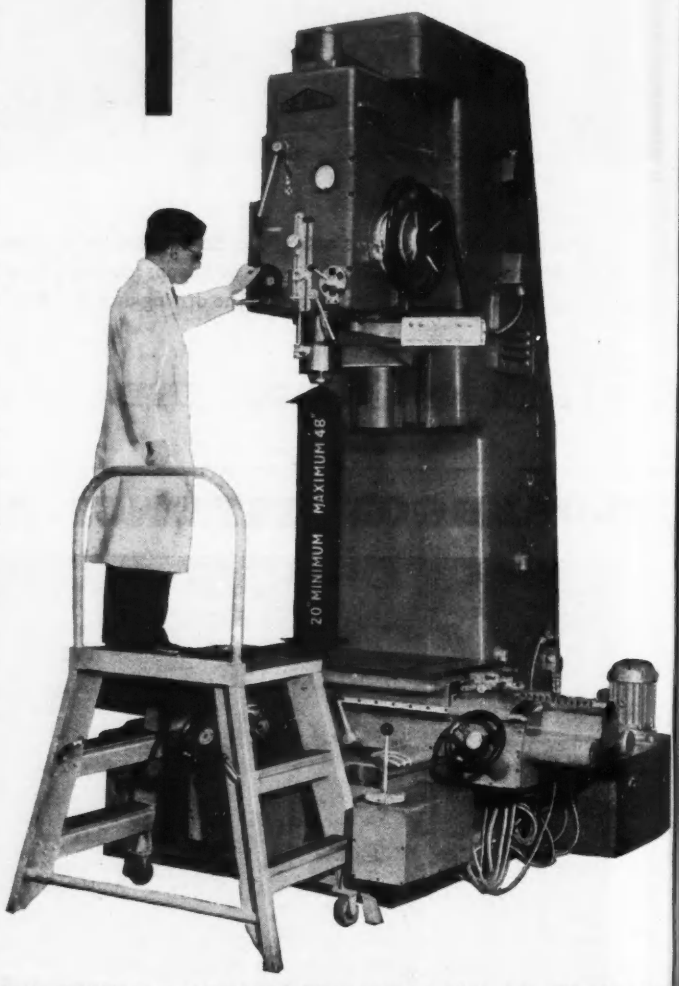

The Newall H2442 is designed to handle batches of large components with the accuracy of a jig borer but at greater speed. Minimum and maximum dimensions from the table to the spindle nose are 20" (508mm.) and 48" (1219mm.) respectively, and open sided construction admits a wider size range of components than would be possible with a bridge type machine. The Newall Patented Roller system of table location guarantees accuracy of setting to .0001" (.002mm), and telescoping guards protect the ways and prevent the ingress of dust, swarf or other harmful matter. Smaller models are also available—details on application.

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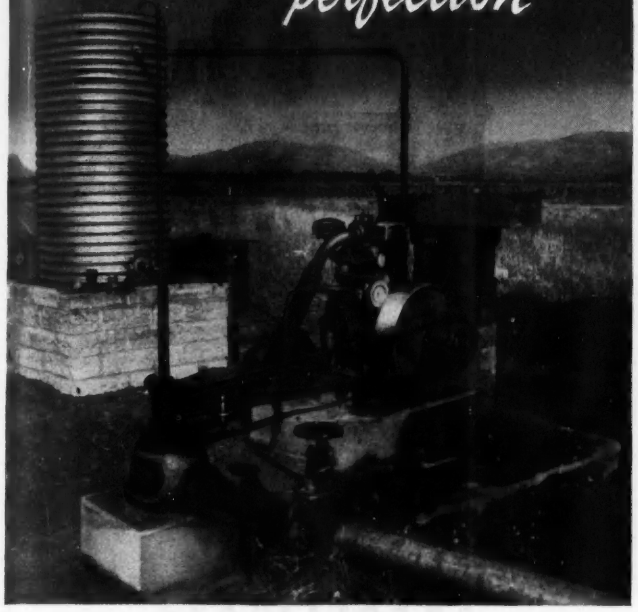

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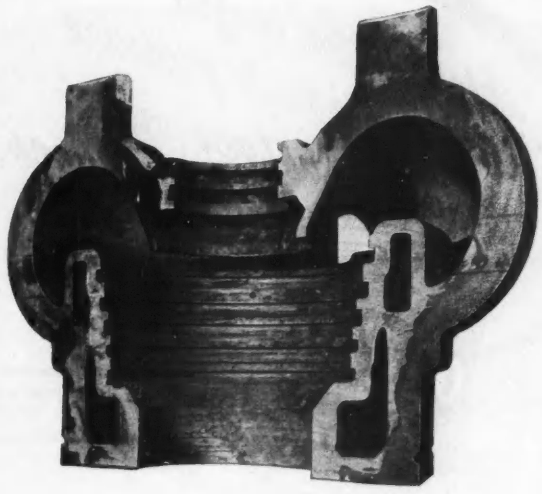

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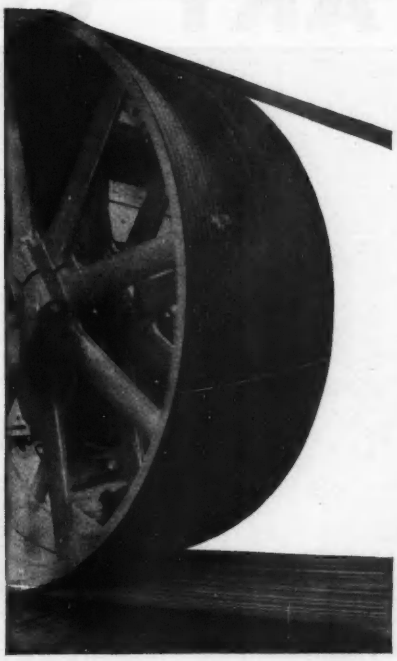

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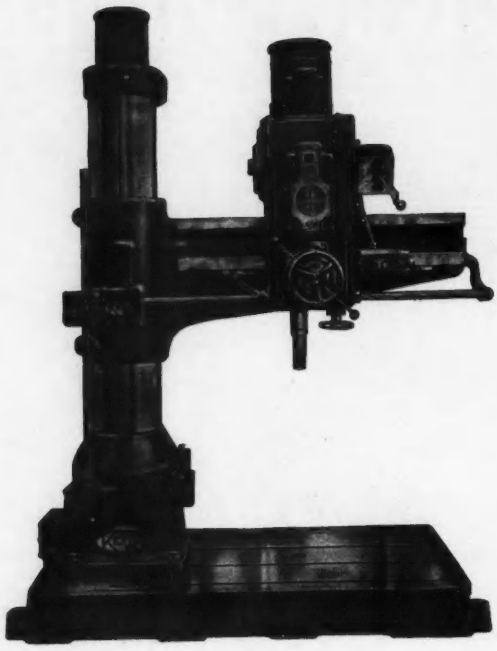

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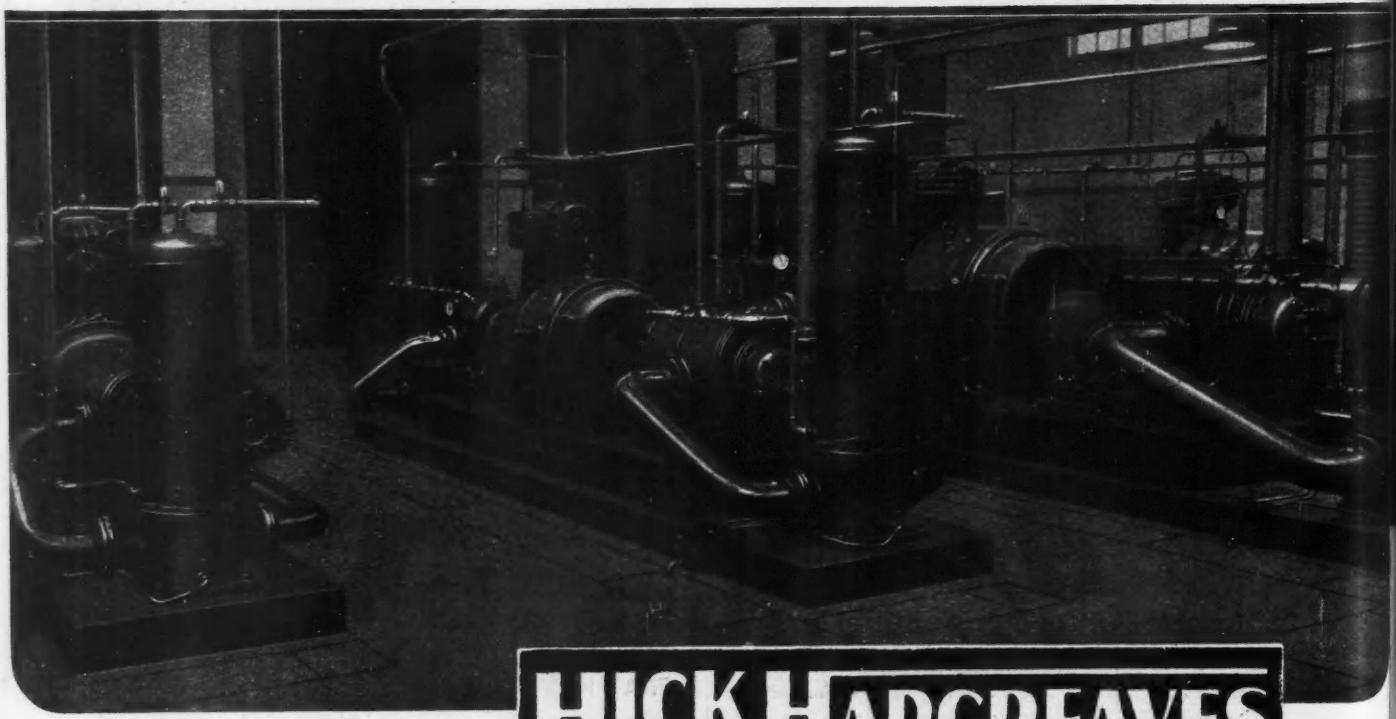

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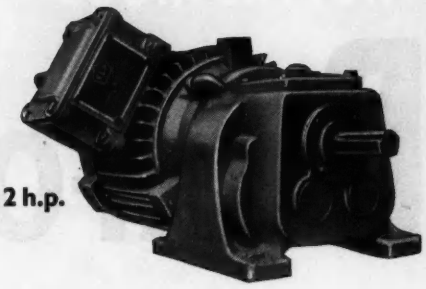

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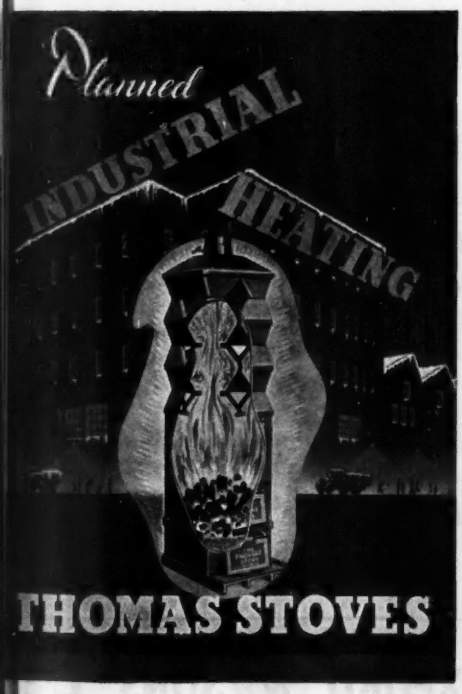

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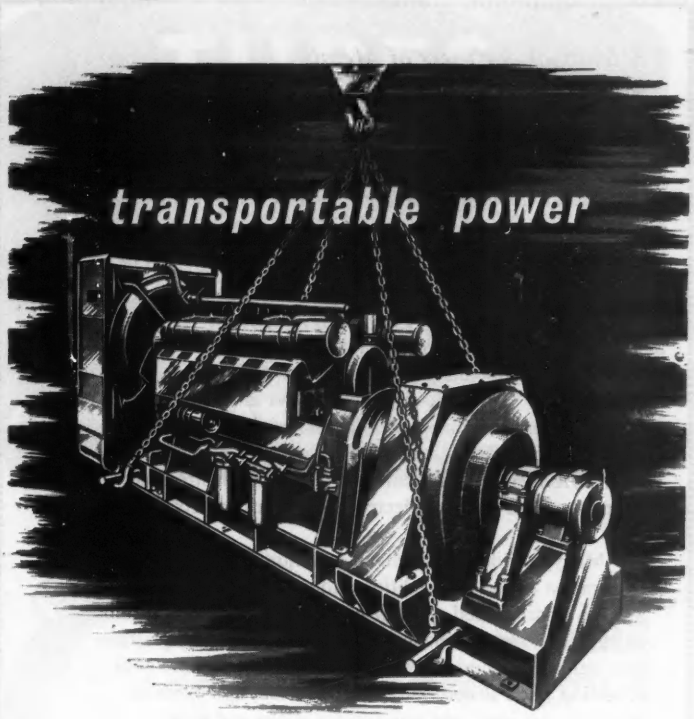

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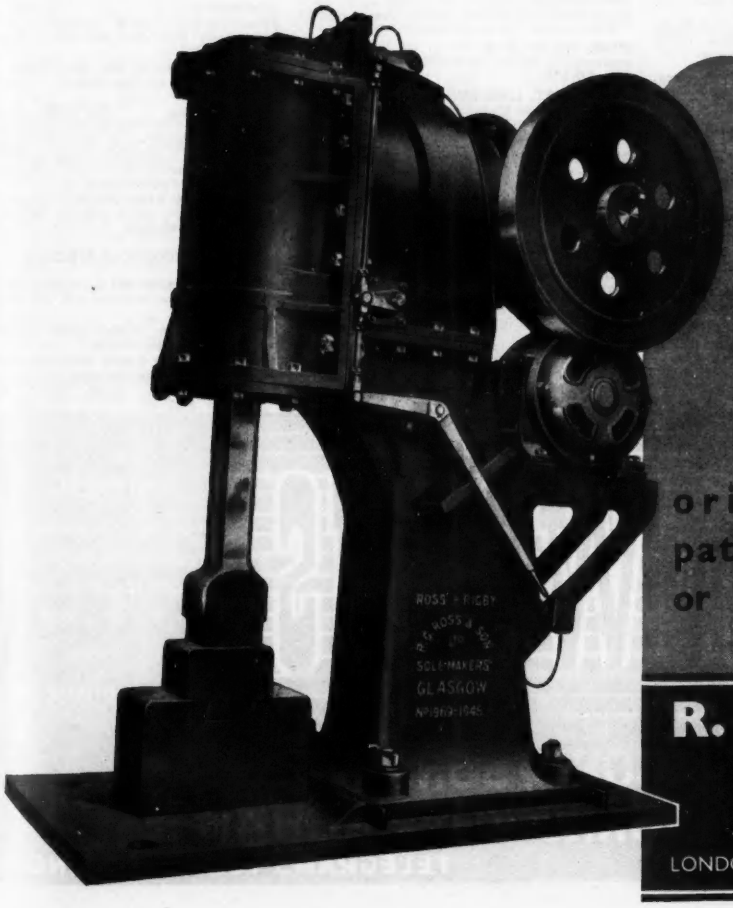

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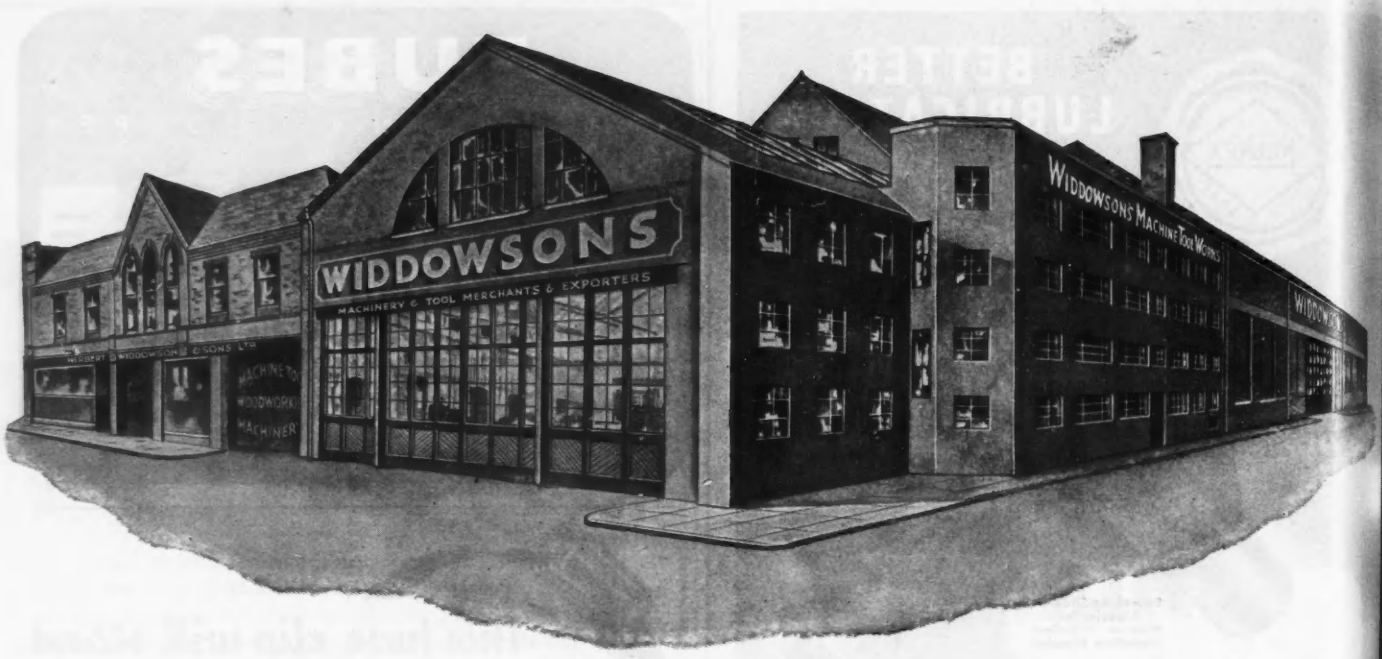

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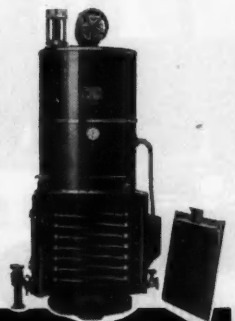

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Send us details of your surplus machinery. Immediate attention and top prices paid. Individual and bulk purchases effected.

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E563 F

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Offers are invited for the purchase of the following second-hand plant.

(a) One 10-ton Barford and Perkins Road Roller, Type THD, with scarifying gear but without engine. Year of manufacture 1928.

(b) One 5-ton Butters rail-mounted, 2-motor Electric Scotch Derrick, suitable for 400 volts, 3 phase, 50 cycle supply, safe working load 5 tons at 94ft., 2 tons at 120ft., wooden cabin. Year of manufacture 1950.

Specifications on request to the Engineer to the Board, Rookery Park, Erdington, Birmingham, 24. Appointments to view on application as follows: (a) Roller—Saltley Works, off Tyburn Road, Erdington, Birmingham (telephone No., East 0046); (b) Derrick—Minworth Works, Kingsbury Road, Minworth, near Birmingham (telephone No., Ashfield 1448).

Offers in writing to undersigned within fourteen days of the appearance of this advertisement.

The Board does not bind itself to accept the highest or any other offers.

ARNOLD L. GREEY, F.C.I.S.,
Clerk to the Birmingham Tame and Rea District Drainage Board,
117, Colmore Row, Birmingham, 3.
15th December, 1953. E6507 G

FOR SALE

One August No. 3 Simpson Sand Mill complete with Bucket Loader, Motor and Gearbox, 200 volts, two-phase, 50 cycles.

Full specification is available and mill can be inspected.

F. H. LLOYD & CO. LTD.,
James Bridge Steel Works,
Near Wednesbury, Staffs. E2983 G

CROP SPRAYERS, Hedgecutters, Air Compressors (stationary, portable and tractor mounted), electric or petrol driven. Send p.c. for details.—Manufactured and fully guaranteed by Romac Industries, Limited, The Hyde, Hendon, N.W.9 (Telephone, COLindale 6055). E576 G

ROBEY HORIZONTAL COMPOUND DROP VALVE ENGINE, 250/300 B.H.P., 80 r.p.m., 100 lb. pressure, flywheel 9ft. 6in. diameter, for 11-1¼in. ropes, jet condenser, air extraction pump. Excellent condition.—Rees Industries, Ltd. Pencoed Works, Bynea, Llanelly ('phone: 1700). E3019 G

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10 TONS ⅜IN. CAST IRON GRATINGS, 2ft. 6in. square and 2ft. 8in. by 1ft. 6in., suitable factory floors; large stocks H.W. Boilers, Radiators, Pipes and Fittings, Circulating Pumps.—C. A. Christiansen, Southall (2294–5–6). E2880 G

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GRINDING MACHINES
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PRATT AND WHITNEY 14IN. VERTICAL SPINDLE HYDRAULIC SURFACE GRINDER, multi-motor drive, reciprocating table, capacity 36in. by 12in. by 16in., table surface 36in. by 12in., grinding wheel dia. 14in., table speeds (infinitely variable) 3–100ft.p.m.

LUMSDEN NO. 7I LEOD VERTICAL SPINDLE SURFACE GRINDER, motor drive, reciprocating table, table surface 60in. by 16½in., table travel 72in., segmental wheel 18½in. dia., max. height under wheel 14in., variable table speeds 10–40ft.p.m.

LANDIS TYPE "C" PLAIN HYDRAULIC CYLINDRICAL GRINDER, motor drive, max. swing 10½in., grinding length 96in., max. dia. ground with new wheel 6in., max. dia. of new wheel 30in., four workhead speeds 49–247 r.p.m.

CHURCHILL MODEL HBY INTERNAL GRINDER, multi-motor drive, max. swing inside guard 12in., max. swing over table 19in., max. distance faceplate to internal spindle bracket 30in., swivel of workhead 30 deg., four workhead speeds 98–350 r.p.m.

BRYANT TYPE 16-C-16 HYDRAULIC INTERNAL GRINDER, motor drive, specially suitable for rough and finish grinding of aero engine cylinder barrels, max. swing without guards 16in., max. travel of wheel slide 16in., max. grinding wheel 16in., workhead speeds from 150 to 450 r.p.m.

CHURCHILL MODEL CRM CRANKSHAFT REGRINDING MACHINE, multi-motor drive, max. swing 20in., max. dia. ground with 30in. wheel 10in., grinding length 72in., grinding wheel 30in. dia. by 1¼in. wide.

JONES AND SHIPMAN FIG. 310 TOOL AND CUTTER GRINDER, motor drive, max. length between cutter head and right-hand tailstock 14in., max. length between tailstock centres 19in., max. swing on standard centres 8in., table 29½in. by 4½in., two grinding spindle speeds 3600 and 5000 r.p.m.

JONES AND SHIPMAN FIG. 309 SPIRAL HOB AND CUTTER GRINDER, motor drive, capacity for cutters max. dia. 8in., max. length 13in., table traverse 13in., lead 3in. to 133in., helix or head angle 0–45 deg., grinding wheel 6in. by ½in. by ¾in.

M.W.N. TYPE "5" PRECISION FACE CUTTER GRINDER, motor drive, specially designed for sharpening left or right-hand milling cutters and cutterheads, max. dia. admitted 19¼in.

ROWLAND 16IN. SWING FRAME GRINDER, motor drive, size of grinding wheel 16in. by 2½in.

SOAG MACHINE TOOLS LIMITED,
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STEAM BOILERS.—Cochran Vertical, 30 in stock, 3ft. to 8ft. 6in. dia., prompt deliveries; Economic, 4ft. to 9ft. dia., including New 7ft. and 8ft. dia., 150 lb. w.p.; Lancashire, 30ft. by 7ft. by 140 lb., 28ft. by 7ft. 6in. by 160 lb., 30ft. by 8ft. by 160 lb., two 30ft. by 9ft. by 200 lb.; 300 reconditioned Vertical Cross-tube, all sizes.

AIR COMPRESSORS.—Browett Lindley 600 cu. ft., 150 H.P. Brook Motor; Ingersoll-Rand, 200/300 cu. ft.; C.P.T., 320 cu. ft.; Holman, 212 cu. ft.; Holman, 100 cu. ft., all motorised, 100 lb. pressure.

200 AIR RECEIVERS stocked up to 9ft. dia., including fifty 8ft. 6in. by 5ft. 6in. by 75 lb.; all tested and guaranteed.

DIESEL ENGINES, HORIZONTAL COLD START.—140 H.P. Crossley, 40 H.P. Crossley, 30 H.P. Babcock.

CRANES.—New 10-ton Smith Loco., 50ft. jib; 8-ton Ransomes Diesel, pneumatics, 1952; 5-ton Tate mobile petrol-electric, new 1942; three in stock; 5-ton Coles petrol-electric, new 1945; 2-ton Chaseside, pneumatics (two); 10-ton Steam Loco. Cranes, 35/40ft. jibs; 5-ton Taylor, 40ft. jib; 3-ton Ruston diesel, 27ft. jib; 2-ton Smith, 40ft. jib; all 4ft. 8½in. gauge.

RAILWAY MATERIAL.—Peckett 0–4–0 14in. by 22in. oil-fired Steam Loco.; Kerr 12in. by 20in., six-wheel coupled Steam Loco., 160 lb. w.p.; large stocks Rails, Points, Wagons.

ELECTRIC MOTORS.—20/150 H.P., 400/3/50, reconditioned.

STEEL PIPING.—10,000ft., 3in. and 6in. screwed; 2000ft., 8in.; 3000ft., 10in.; 1000ft., 12in. flanged; 10,000ft., 4in. Victaulic; 500 steel bends, 6in., 8in., and 10in.; Flexible Pumping Hose, 4in., 8in., 10in. bore, flanged as new.

CAST IRON PIPES.—5000ft., each new 6in., and 8in. flanged, immediate delivery. Also other sizes.

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STORAGE TANKS.—Two Lead-lined, 35ft. long, 9ft. dia.; 200 Steel Vessels for oil, bitumen, acids; Fifty dish-ended Pressure Tanks, 8ft. 6in. by 5ft. 6in. dia., 29ft. by 9ft. 8in., Welded Steel, 50 lb. pressure; Six O.T., 7ft. dia., 14ft. deep, rubber and brick-lined.

Comprehensive catalogue, "Watkins Machinery Record," published monthly; free copy on request.

SLING ENGINEERING WORKS,
COLEFORD, GLOS.
'Phone: Coleford 2271/2. E366 G

SCRIVENER No. 2 Centreless, good selection other Machines.—M. Rock and Sons, Ltd., 15, Whitehorse Road, Croydon (THO 5405). E2944 G

For continuation of Small Advts., page 96

The Productivity Report on
FUEL CONSERVATION
says . . .
We again strongly recommend that industry, particularly heavy engineering, should investigate more closely the economics of the waste heat boiler . . . The potential fuel saving is very substantial and should be pursued."
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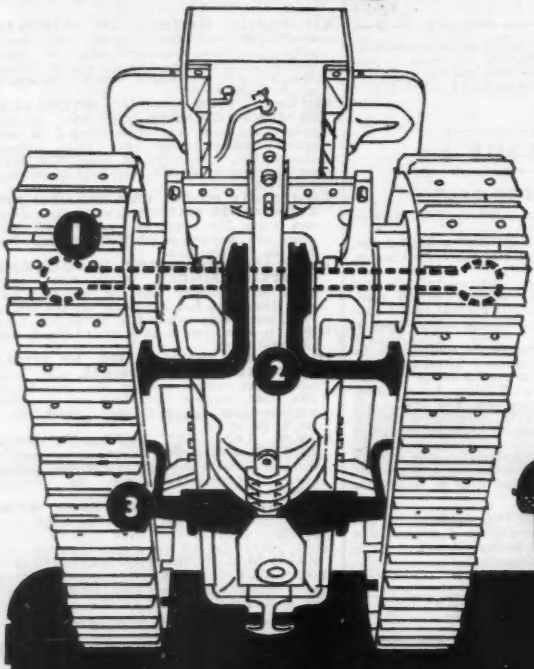
Spencer-Bonecourt Ltd
The Waste Heat Recovery Specialists
4 Fetter Lane, London, E.C.4. 'phone: CENtral 0481/2. 'grams: "Bonecourt, Fleet, London."

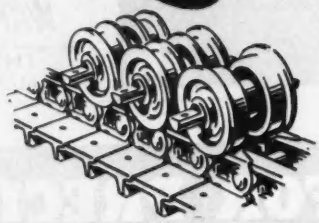
International 3-point Track Suspension gives you 3 Big Advantages



1 The track frames are mounted at the ends of the pivot shaft by well sealed and lubricated ball-and-socket joints. These permit free oscillation of the tracks, yet entirely eliminate leverage loads on the pivot shaft.

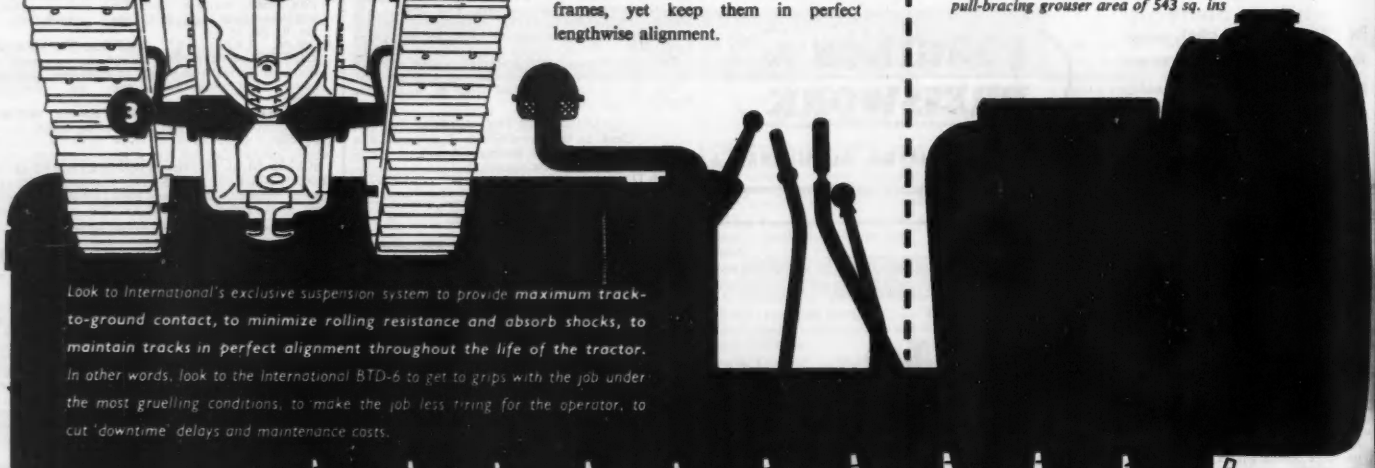
2 These sturdy steel braces, which are allowed rotary and sideways movements on the pivot shaft, are securely attached to the track frames and obviate any possibility of the tracks tilting inwards or outwards.

3 The front stabilizers and the massive leaf spring permit considerable up-and-down movements of the track frames, yet keep them in perfect lengthwise alignment.

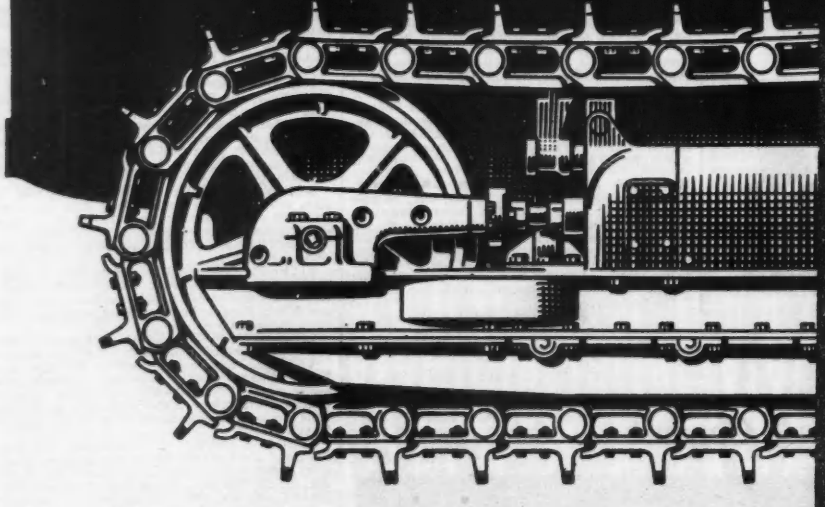


Light-treading, Sure gripping, Long-wearing tracks

The weight of the BTD-6 is supported by tracks with a ground contact of 1,641 sq. ins., resulting in a ground pressure of only 4.62 lbs. per sq. in. The heat-treated steel track shoes, which are keyed to the track links, provide a pull-bracing grouser area of 543 sq. ins



Look to International's exclusive suspension system to provide maximum track-to-ground contact, to minimize rolling resistance and absorb shocks, to maintain tracks in perfect alignment throughout the life of the tractor. In other words, look to the International BTD-6 to get to grips with the job under the most gruelling conditions, to make the job less tiring for the operator, to cut 'downtime' delays and maintenance costs.



INTERNATIONAL

BTD-6

DIESEL CRAWLER TRACTOR

INTERNATIONAL HARVESTER

This rugged British-built crawler, with its quick-starting 40.5 b.h.p. engine, is the popular size for a long list of earthmoving and construction jobs. For full details see your International Industrial Dealer, or send for the illustrated brochure.

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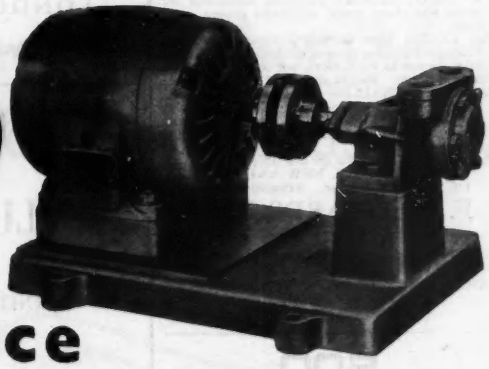

This Standard model is the ideal pump for lubricating oils, fuel oils and non-corrosive liquids.

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- COMPLETE MOTORISED SETS

ROTOPLUNGE PUMP COMPANY, FLAXLEY ROAD, STECHFORD, BIRMINGHAM

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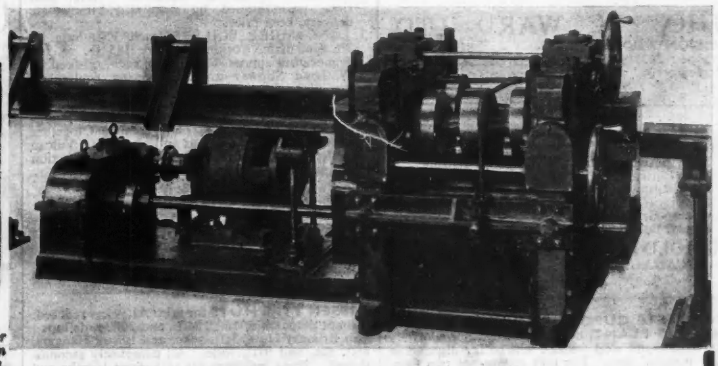
80,000 to 120,000

Steam and Superheater Tubes De-Scaled per year



Machine suitable for dealing with both Steam and Superheater Tubes.

As well as above we manufacture all types of Straightening Machines, Reeling Machines, Countersinking Machines and Rivet Making Plant.

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WICKMAN 4mm. Swiss type, single spindle automatics, manufactured by the Vinco Corporation, Michigan, Detroit, Serial Nos. 68–324, 68–318, 68–348, 68–344, 68–347, max. bar capacity 5/32in., max. turning length 1 5/16in., number of spindle speeds possible 28, range of spindle speeds 1500–12,000 r.p.m., range of production cycles 2 secs. –4 mins., two of the machines are complete with high-speed back drilling attachment.

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LUMSDEN type 92LE, vertical spindle, rotary Surface Grinding Machines, fitted segmental wheel, direct motor drive, late type, wheel dia. 26in., table dia. 48in., capacity inside guards 58in., max. height under wheel 18in., horse-power of spindle motor 40.

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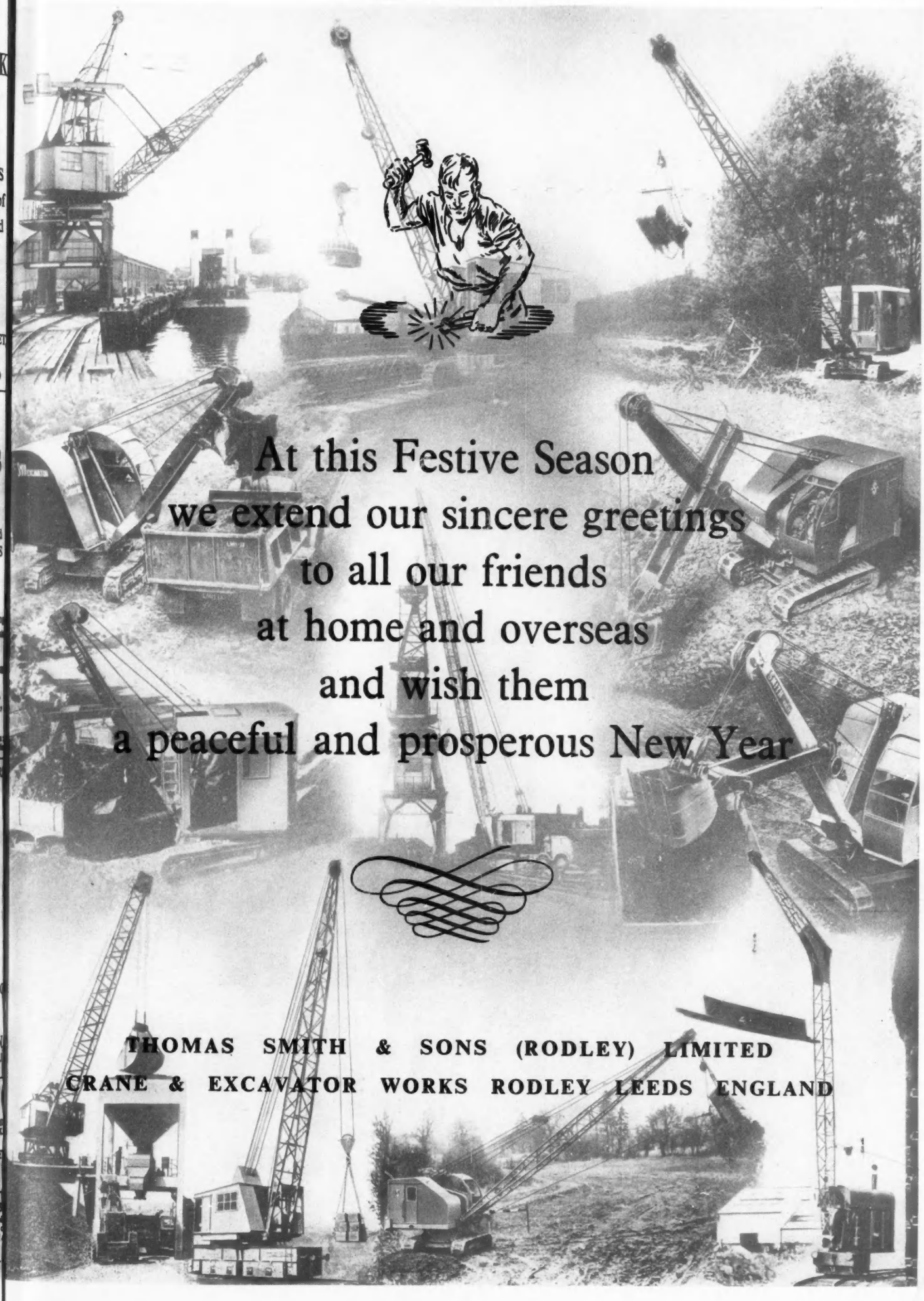
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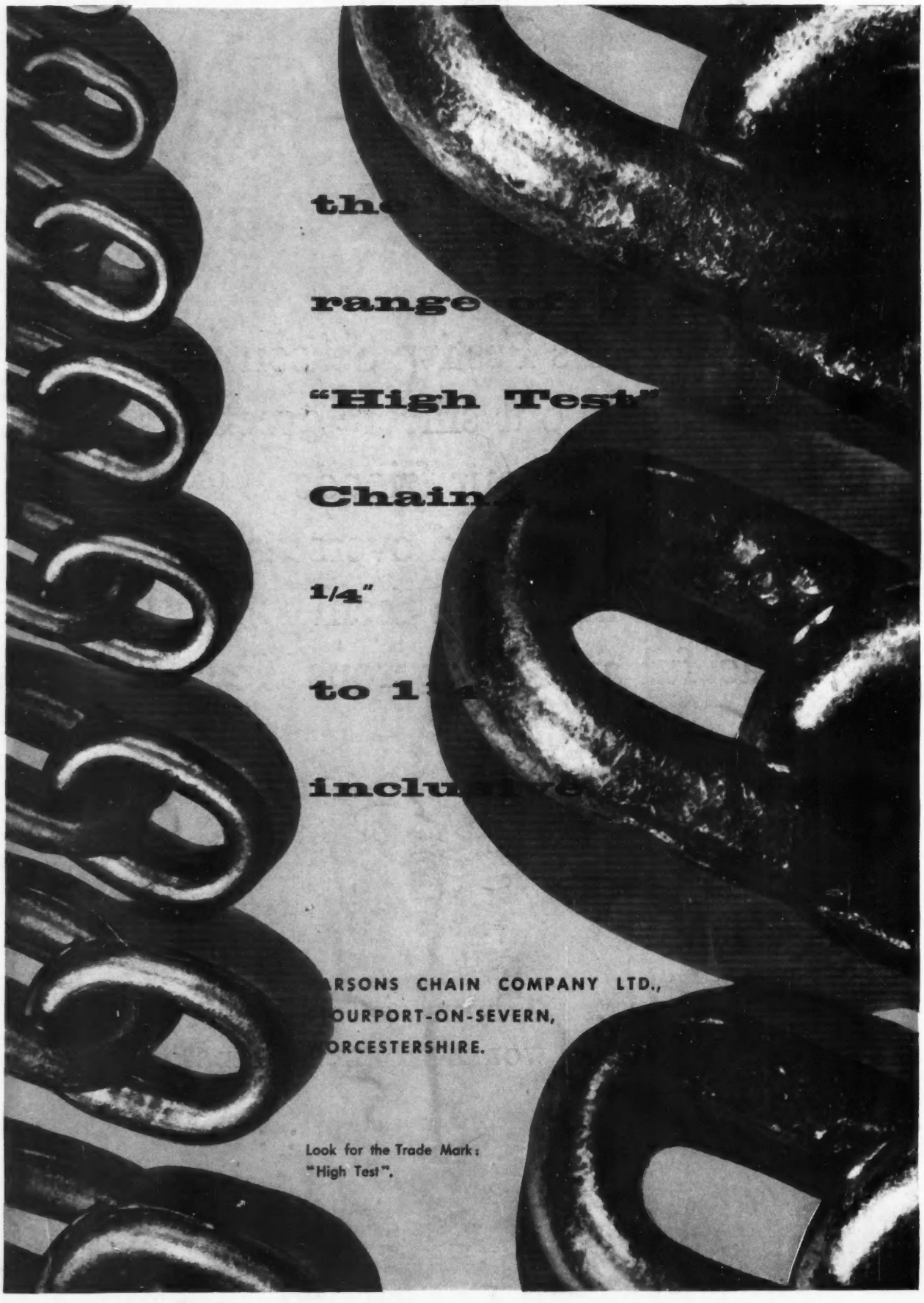
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